WORKSHOP RECEIPTS.

(SECOND SERIES.)

BY

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PREFACE.

ENCOURAGED by the remarkable success of the original 'Workshop Receipts,' the author has ventured to produce a second series on the same pattern.

In all branches of applied science—whether chemical, electrical, metallurgical, or mechanical—there are numerous subjects which, taken alone, are not sufficiently large or important to deserve a separate volume for their description, but which, at the same time, are of considerable interest to scientific amateurs and to manufacturers on a moderate scale. These subjects, unworthy a place in the great industrial encyclopædias, such as Spons', Ure's, or Muspratt's, are well adapted for arranging in groups in a less pretentious volume like the present. In addition to the lesser industries, there are a number of recipes and hints connected with the larger industries, which, though generally based on rule of thumb rather than on scientific principles, have, nevertheless, great practical value, and often ensure success where other means fail; these are usually overlooked or despised by theoretical writers, though they represent the knowledge gained by actual experience, and are jealously regarded as trade secrets by their possessors. These, arranged conveniently, cannot fail to attract attention.

The writer of the present volume has had the advantage of being made acquainted with the suggestions from various sources which the original work called forth, and he has endeavoured to utilize them to the utmost in improving the arrangement of subjects and other details. The matters discussed here have all more or less intimate connection with chemical trades, and bear some relation to each other. In a very few instances, recipes which appeared in the original work have been repeated here: when such is the case, they have been necessary, in order to make a subject complete; and opportunity has at the same time been taken to amplify them in a manner which renders them practically new.

In conclusion, the work is provided with a full list of contents, and an index about which no pains have been spared.

ROBERT HALDANE.

London, *July*, 1883.

CONTENTS.

Acidimetry and Alkalimetry: ready means of estimating the acidity and alkalinity of liquids.

Albumen: occurrence, characters, composition, impurities, qualities, uses, coagulation, restoration to coagulable state; full details of manufacture of Blood albumen, Egg albumen, Fish albumen, and Vegetable albumen, with suggestions as to new sources.

Alcohol: sources; synopsis of manufacture of Caustic alcohol (sodium ethylate), and alcohol from Fruit, Grain, Molasses, Moss, and Roots; rectification; and Wood alcohol (pyroxylic spirit).

Alkaloids: general methods of preparation; special methods for Aconitine, Atropine, Berberine, Brucine, Calumbine, Cascarilline, Colchicine, Morphine, Narcotine, Nicotine, Piperine, Quinine (including amorphous quinine and quinetum), Salicine, Strychnine, and Veratrine.

Baking-powders: general remarks on true value and essential conditions, and many recipes for their preparation.

Bitters: recipes for Amazon, Angostura, Aromatic, Boker's, Brandy, Essence, French Cognac, Hamburg, Nonpareil, Orange, Peruvian, Spanish, Stomach, Stoughton, and Wild Cherry bitters.

Bleaching: recipes for bleaching and decolorizing Albumen, Animal fibres, Coral, Cotton, Esparto, Feathers, Guttapercha, Hair, Ivory, Jute, Linen, Oils and Fats, Paper Pulp, Paraffin, Rags, Shellac, Silk, Silver dials, Sponge, Starch, Straw, Wax, Wool.

Boiler Incrustations: numerous analyses of feed waters from rivers, lakes, wells, town supply, rain, canals, pits, springs, and the sea, with analyses of the incrustations produced by them, and a critical examination of the various chemical, chemico-mechanical and physical processes for preventing boiler corrosion.

Cements and Lutes: general directions for the preparation and application of cements and lutes; numerous recipes under the following heads:—Acid-proof, Alabaster, Algerian, Almond paste, Amber, Aquarium, Architectural, Armenian or Diamond, Badigeon, Bottle, Brimstone, Buckland's, Canada balsam, Cap, Casein, Chemical, Chinese or Schio-liao, Chinese glue, Chrome, Coppersmiths', Corks, Crucible, Curd, Cutlers', Dextrine, Egg, Elastic, Engineers', Fat, Fireproof, French, Glass, Glass to Metals, Glue (including Fish glue, Lapland glue, Liquid glue, Mouth or Lip glue, Portable glue), Glycerine, Gum-arabic, Gum tragacanth, Hensler's, Indiarubber, Iron, Isinglass, Ivory, Japanese, Jewellers', Kerosene lamps, Labels, Laboratory, Lead, Leather, Mahogany, Marble, Marine glue, Masons', Meerschaum, Metal to glass, stone, &c., Microscopical, Milk, Naturalists', Opticians', Parabolic, Parian, Paris, Paste, Peasley, Plasters, Plumbers', Porcelain, Putty, Sealing-wax, Shellac, Soluble glass, Sorel's, Steam, Stone, Turners', Waterproof, Wollaston's, Wood, Zeiodelite.

Cleansing: a complete selection of recipes for washing, cleaning, scouring, purifying, and removing stains, arranged under the following heads:—Brass, Bronze, Casks, Celluloid, Chip bonnets, Coins, Copper vessels, Druggists' utensils, Engravings, Feathers, Fire-arms, Floors, Fur, Gas chandeliers, Gilt mountings, Gilt picture frames, Glass (bottles, globes, plates, slides, paint stains, windows), Gloves, Gold, Iron and Steel, Ivory and Bones, Leather, Marble, Mirrors, Oilcloth, Paint, Paint-brushes, Paintings, Parchment,

Sheepskin mats, Silver, Sponge, Stains removing (aniline, fruit and wine, grease and oil, ink and ironmould, lime and lyes, mildew, milk and coffee, paint and varnish, stearin, tannin, tar and axle-grease), Stills, Stones, Stuffed animals, Teapot, Textile fabrics (English and French cleaning and scouring, cleaning with benzine, apparatus used, methods of operation for ancient tapestry, carpets, cloth, curtains, and bed furniture, dresses, flannel, hearthrugs, lace, shawls and scarves, sheepskin rugs and mats, silk goods, table covers), Tobacco pipes, Vellum, Violins, Violin bows, Wall papers, Zinc vessels.

Confectionery: the confectioners' stove, clarification of sugar, boiling degrees of sugar; methods of making Cakes (Bordeaux, pound, Italian bread, Savoy, wafers), Candied sugar (chain, crystallized chocolate, crystallized fruits, liqueur rings), Candy (artificial fruit and eggs, burnt almonds, coconut ice, coltsfoot candy, filberts and pistachios, ginger candy, lemon prawlings, orange prawlings, peppermint, lemon and rose candy, plum candy, sweetflag candy), Chocolate (roasting, making, drops, harlequin pistachios, cinnamon, mace, clove, stomachic and vanilla chocolate), Comfits (almond, barberry, caraway, cardamom, celery, cherry, cinnamon, clove, colouring, coriander, flavoured with liqueurs, ginger, lemon peel or angelica, nonpareils, orange, raspberry), Crack and Caramel (acid drops and sticks, almond hardbake, almond rock, barley sugar drops and tablets, brandy balls, clove, ginger, or peppermint rock, extracting the acid from candied drops, nogat, raspberry rock or sticks, spinning, almond baskets, Chantilly baskets, gold web, grape, orange or cherry baskets, raspberry rock, rock sugar, silver web), Drops (catechu, chocolate, cinnamon, clove, coffee, ginger, lemon, orange-flower, orgeat, peppermint, raspberry, rose, vanilla, violet), Ices (apparatus, freezing, almond or orgeat ice cream, apple water ice, apricot water ice, barberry, biscuit cream, brown bread ice, burnt almond ice cream, burnt ice cream, cherry ice cream, cherry water ice, chestnut ice, chocolate ice, coffee ice cream, cream ice, currant ice, currant water ice, custard for ices, custard ices, damson ice, filbert ice cream, ginger ice, gooseberry water ice, lemon ice cream, lemon water ice, liqueur cream ice, liqueur water ice, millefruit ice cream, millefruit water ice, noyau cream ice, orange ice cream, orange water ice, peach ice, peach water ice, pineapple ice, pineapple water ice, pistachio ice cream, punch water ice, raspberry ice, raspberry water ice, ratafia cream, Roman punch ice, strawberry ice, strawberry water ice, Swiss pudding, tea ice, vanilla ice), Lozenges (bath pipe, brilliants, catechu, cinnamon, clove, coltsfoot, ementine, ginger, ipecacuanha, lavender, magnesia, marshmallow, nitre, nutmeg, pattarosa, peppermint, refined liquorice, rhubarb, rose, saffron, sponge, steel, sulphur, tolu, vanilla, worm, yellow pectoral, zinc).

Copying: obtaining copies of printed and written matters by Chemical methods (including cyanotype or ferro-prussiate paper, cyanoferric or gommoferric paper, Joltrain's, Beneden's, Dietrich's, autoscopic, Tilhet's, Zuccato's, Pumphrey's, Waterlow's, hectograph or chromograph, Magne's, Willis's, Poitevin's, Woodbury's, photo-lithographic, Niépce's, Ehrard's, Fox Talbot's, Scamoni's, Nuth's, phototypy, Michaud's, chromotype, Lenoir's, Warnerke's, Edwards' heliotype, Waterhouse's, Alissoff's polygraphic, Asser's, Komaromy's, and numerous other processes); by Mechanical methods (embracing stencils of various kinds, tracing on cloth, tracing-cloth, and other recipes); Copying Pencils; Transferring (photographs to wood, engravings to paper, transfer process on glass).

Disinfectants: the preparation and characters of all the substances hitherto proposed as deodorizers, disinfectants, or antiseptics, with comparative tables of results according to different authorities, and discussions on the advantages and disadvantages of the disinfectants now before the public.

Dyeing, Staining, and Colouring: containing a most comprehensive collection of new and approved recipes, under the following heads—Calico-printing, in chrome standard, discharge style (blacks, blues, whites, yellows), indigo effects (direct indigo blues, lapis resists, combined indigo and madder effects, white reserves, white resists, orange reserves, yellow reserves, blues, and white, red, green and yellow, green, and yellow discharges on vat-blues), madder colours (blacks, browns, chocolate, drab, purples, reds, whites), manganese bronze style, padding style, pigment style, plate style, reserve style, spirit colour style (blues, browns, chocolate, greens, pinks, purples, reds, yellows), steam colours (amber, blacks, blues, browns, buff, chocolates, cinnamon, drab, greens, greys, lavender, lilac, orange, pinks, purples, reds, violets, yellows); China grass; Cotton (blacks, blues, browns, chocolate, claret, drabs, greens, greys, olive, oranges, purples, reds, violets, yellows); Encaustic colours; Feathers; Flowers, Grasses, and Mosses; Hats (beaver, cream, fawn, mouse, rose, slate, cinnamon); Horn (blacks, greens, purples, reds, tortoiseshell, yellow); Horsehair (blue, brown, red); Ivory (blacks, blues, browns, greens, reds, yellows), vegetable ivory; Kid gloves (blacks, browns, Russian red, grey, violet, yellow); Leather (blacks, blues, browns, russets, reds, yellows, greens, violets, purples, crimson); Metals (brass, bronze, gold, gun-metal, iron and steel, silver, zinc); Paper (ambers, blues, browns, buffs, chocolates, crowfoot, fawns, greens, greys, lilacs, Nankeen tissue, olives, oranges, pinks, reds, roses, skin colour, straw tint, violet, white tissue, yellows); Parchment; Silk (blues, greens, magentas, maroons, pansy, scarlets, violets, yellows); Straw; Whitewashing, calcimining, or distemper; Wine; Wood (blacks, blackboard washes, blues, browns, ebonizing, floors, greens, greys, mahogany, oaks, purples, reds, satinwood, violet, walnut, yellows); Wool (amaranth, blacks, blues, greens, grenades, greys, maroons, olives, oranges, ponceau, puce, reds, violets, wood-colour).

Essences: Aconite, Allspice, Almonds, Ammoniacum, Anchovy, Angelica, Aniseed, Anodyne, Antihysteric, Aromatic, Bark, Beef, Bitter, Camphor, Caraway, Cardamom, Cascarilla, Cassia, Cayenne, Celery, Chamomile, Cinnamon, Cloves, Cochineal, Coffee, Coltsfoot, Cubebs, Dill, Ergot, Fennel, Fruit (artificial, including apple, apricot, banana, blackberry, black cherry, cherry, currant, grape, lemon, nectarine, orange, peach, pear, pineapple, plum, raspberry, strawberry), Ginger, Guaiacum, Headache, Hop, Lemon, Lemon-peel, Lovage, Nutmeg, Orange, Orange-peel, Pennyroyal, Peppermint, Quassia, Quinine, Rennet, Rhubarb, Royale, Sarsaparilla, Savoury Spices, Soap, Soup Herbs, Spruce, Turtle, Water Fennel, Westphalian, Wormwood.

xtracts: preparation; Aconite, Aloes, Angelica, Apples, Belladonna, Buchu, Cainca, Calabar Bean, Calumba, Cherry (Wild), Cinchona, Colchicum, Colocynth, Cotton-root, Cubebs, Ergot, Gentian, Golden Seal, Hellebore, Hops, Jaborandi, Jalap, Juniper, Lactucarium, Lettuce, Lobelia, Logwood, Madder, Male Fern, Malt, Meat, Mezereon, Myrrh, Narcotic, Nux Vomica, Opium, Pareira, Pellitory, Pinkroot, Poppies, Quassia, Rhatany, Rhubarb, Sarsaparilla, Scammony, Senna, Smoke, Squills, Stillingia, Stramonium, Taraxacum, Tobacco, Valerian, Wormseed.

eproofing: Buildings, Extinguishing Compounds, Textile Fabrics, Timber, Writing Materials.

atine, Glue, and Size: manufacture of glue, manufacture of size, drying glue, composition of glue, characters of glue, selection of glue, manufacture of gelatine from bones, Rice's gelatine, Cox's sparkling gelatine, Heuze's gelatine rom neats'-foot-oil residues, Nelson's gelatine, comparison of gelatines, prevent-
ng nuisance at glue-works.

cerine: sources, early processes, Price's method, obtaining glycerine from pent lyes of the soapmaker—a discussion of the numerous methods recently proposed, purifying glycerine, characters, impurities and their detection, solvent owers of glycerine, various uses.

: the preparation of gut for fiddle-strings and sausage-skins; silk-worm gut.

rogen peroxide: manufacture and application.

Ink: Black writing, Coloured writing, Copying, Engraving, Indelible, Indian, Invisible or Sympathetic, Marking, Miscellaneous, Printing, and Stamping inks.

Iodine: manufacture from seaweeds, and from caliche.

Iodoform: processes for making.

Isinglass: from fish, and from various kinds of seaweed.

Ivory substitutes: numerous ways of preparing artificial substitutes for ivory, such as celluloid, &c.

Leather: Calf-kid, Chamois leather, Currying, Depilatories or Unhairing, Glove-kid, Imitation leather, Morocco leather, Patent (Japanned or Enamelled) leather, Russia leather.

Luminous bodies: natural phosphorescent substances; artificial luminous paints—Balmain's, Heaton and Bolas', &c.

Magnesia: new and cheap way of preparing.

Matches: general sketch of manufacture, especially with regard to the ingredients, &c., of igniting compositions; Vestas and Vesuvians.

Paper: selection and assortment of rags; boiling raw materials; recipes for high-class papers; washing and breaking; draining and pressing. Astronomical drawing-paper, Blotting-paper, Crystalline paper, Deciphering burnt documents, Filtering-paper, Hardening paper, Iridescent paper, Lithographic paper, Luminous paper, Oiled paper, Packing-paper, Safety-paper, Smoothing paper, Splitting a sheet of paper, Test-papers, Tracing-paper, Transfer-paper, Waxed paper.

Parchment: preparation of natural parchment, and artificial parchment or parchment paper; removing wrinkles from parchment.

Perchloric acid: cheap mode of making.

Pigments, Paint and Painting: embracing the preparation of *Pigments*, including alumina lakes, blacks (animal, bone, Frankfort, ivory, lamp, sight, soot), blues (antimony, Antwerp, cobalt, cæruleum, Egyptian, manganate, Paris, Péligot, Prussian, smalt, ultramarine), browns (bistre, hinau, sepia, sienna, umber, Vandyke), greens (baryta, Brighton, Brunswick, chrome, cobalt, Douglas, emerald, manganese, mitis, mountain, Prussian, sap, Scheele's, Schweinfurth, titanium, verdigris, zinc), reds (Brazil-wood lake, carminated lake, carmine, Cassius purple, cobalt pink, cochineal lake, colcothar, Indian red, madder lake, red chalk, red-lead, vermilion), whites (alum, baryta, Chinese, lead sulphate, white lead—by American, Dutch, French, German, Kremnitz, and Pattinson processes, precautions in making, and composition of commercial samples—whiting, Wilkinson's white, zinc white), yellows (chrome, gamboge, Naples, orpiment, realgar, yellow lakes); *Paint* (vehicles, testing oils, driers, grinding, storing, applying, priming, drying, filling, coats, brushes, surface, water-colours, removing smell, discoloration; miscellaneous paints—cement paint for carton-pierre, copper paint, gold paint, iron paint, lime paints, silicated paints, steatite paint, transparent paints, tungsten paints, window paint, zinc paints); *Painting* (general instructions, proportions of ingredients, measuring paint work; carriage painting—priming paint, best putty, finishing colour, cause of cracking, mixing the paints, oils, driers, and colours, varnishing, importance of washing vehicles, revarnishing, how to dry paint; wood-work painting.

Potassium oxalate: new and easy way of making it for photographic purposes.

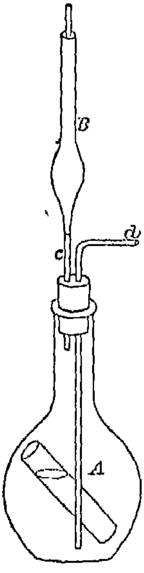
Preserving: charred paper, food (beer, fish; fruit, grain, and vegetables; honey, meat, milk), fruit-juices, gum, hay, indiarubber, leather, leeches, lemon-juice, Rankin's and Pasteur's fluids, skins and furs, stone, textile fabrics, urine, vaccine lymph, wood.

WORKSHOP RECEIPTS.

SECOND SERIES.

ACIDIMETRY and **ALKALIMETRY.**—These two terms may be conveniently described together, as the operations involved are intimately related, and the apparatus in some respects identical.

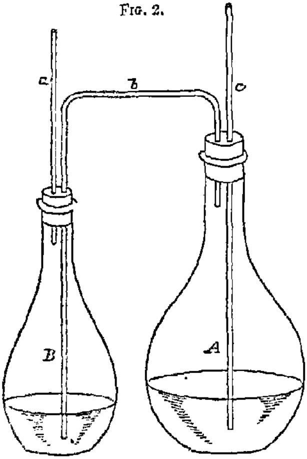
FIG. 1.



Acidimetry is the "measuring of acids," or determining the amount of free acid in an acidulous liquid. It does not indicate the nature of the acid, nor whether more than one acid is present. Three principal methods are available:—(1) The strength of an acid solution may be approximately determined by its boiling-point (see Boiling-points); (2) by its specific gravity (see Specific gravity); (3) by the amount of carbonic acid gas evolved from bicarbonate of soda by a measured quantity of the acid liquid. This last is perhaps the simplest process, and that generally in use. The apparatus required is shown in Fig. 1, and may be constructed by the operator. It consists of a wide-mouthed flask A, furnished with a tightly-fitting cork, through which pass 2 glass tubes *cd.* The tube *c* terminates in a bulb B, filled with chloride of calcium; the bent tube *d* reaches nearly to the bottom of the flask. A carefully weighed quantity of pure bicarbonate of soda is introduced into the flask, and covered with distilled water. This done, a small glass test-tube, containing a known volume of the acid to be examined (which must not be sufficient to decompose the whole of the alkali), is carefully lowered into the flask, in the position shown. The flask is then corked up, and accurately weighed on a delicate balance. After this, the acid in the test-tube is run out upon the alkali by causing the tube to slip into a horizontal position. By this means, a part of the alkali, equivalent to the amount of real acid in the liquid, is decomposed, the carbonic acid gas evolved escaping through the bulb-tube B; any moisture which may be carried upwards mechanically is absorbed by the chloride of calcium, whose affinity for water is well known. When the whole of the acid has been neutralized, and the disengagement of gas has ceased, air is sucked through the tube B in order to withdraw any gas remaining in the flask and tubes. When perfectly cool, the whole apparatus is reweighed. The difference between the two weighings represents the weight of carbonic acid expelled, and from this the amount of real acid in the volume of liquid operated upon is calculated by multiplying it by the combining weight of the acid and dividing the product by 44, the combining weight of carbonic acid gas. Thus, suppose the weight of the apparatus before the experiment be 32·355 *grm.*, and after the experiment 31·785 *grm.*, the loss in weight, ·570 *grm.*, represents the amount of gas evolved from the bicarbonate of soda by the acid (say sulphuric acid). Then, $\frac{\cdot 570 \times 98}{44} = 1\cdot 27$ *grm.* of real sulphuric acid, the amount contained in the volume of liquid taken for experiment. The same method applies to the estimation of any acid which decomposes carbonates, the combining weight of such acid being substituted for that of sulphuric acid used in the above example.

Another application of the same principle is a method devised by Fresenius and Will. The apparatus is shown in Fig. 2, and consists of 2 small flasks, A B, A being slightly the larger.

FIG. 2.



These are furnished with tightly-fitting corks, through each of which pass the glass tubes *a b c*, arranged as shown. The flask B is half filled with concentrated sulphuric acid, and in the other is placed the acid to be tested, accurately measured, and, if necessary, diluted with water. A test tube is now introduced into the flask A, in the same manner as described in the previous case; this tube contains bicarbonate of soda, in quantity more than sufficient to neutralize the whole of the acid contained in the sample. After carefully weighing the apparatus, the acid and alkali are allowed to mix; carbonic acid is evolved, passes through the sulphuric acid in the other flask, being thereby thoroughly dried, and escapes through the tube *a*. All effervescence having ceased, air is drawn through the 2 flasks by sucking at the extremity of the tube *a*, to remove any traces of carbonic acid remaining behind. When quite cool, the apparatus is re-weighed, the loss representing the amount of carbonic acid disengaged from the alkali. The calculation to find the total quantity of acid in the volume of liquid employed is, of course, the same as in the preceding example.

Alkalimetry is the determination of the quantity of real alkali in alkaline salts and solutions. As in the case of acidimetry, the determinations may be made either by gravimetric or by volumetric analysis.

Gay-Lussac's method is based upon a titrated solution of carbonate of soda with a corresponding solution of sulphuric acid. Instead of the carbonate, it is preferable to use caustic soda, in order to avoid the objectionable interference caused by the presence of carbonic acid. The indicator employed is a solution of litmus, made by digesting about 10 *grm.* of litmus in ½ *litre* of distilled water for a few hours; the clear liquid is decanted and kept in a small, tightly-corked wash-bottle, from which a few drops can be expelled when required. A very small quantity of dilute nitric acid may be advantageously added to the solution, in order to produce a violet colour, which increases the sensibility of the indicator. The standard solution of sulphuric acid contains 49 *grm.* of real sulphuric acid per *litre*, and may be made in the following way:—30 *cc.* of the pure acid, 1·840 sp. gr., is diluted with water in a beaker, and the mixture is left to stand; when perfectly cool, it is washed into a *litre* flask, and diluted to the containing-mark. The solution is next tested with a standard solution of carbonate of soda, containing 53 *grm.* of pure carbonate to the *litre*, carefully weighed and measured; 10 *cc.* of this latter solution is placed in a beaker with a little distilled water and a few drops of the litmus solution, and the acid is run in carefully and slowly until the point of saturation is reached. If more than 10 *cc.* be required, the solution is too weak; if less, it is too strong, and it must either be strengthened or diluted, as the case may be, until 10 *cc.* of each solution *exactly neutralize each other*. In order to insure perfect accuracy, larger quantities of the two substances, say 50 or 100 *cc.*, may be employed, when the difference, if any, will be more readily detected. If caustic soda be used instead of carbonate, about 42 *grm.* is to be dissolved in water (about 800 *cc.*); the above test is applied, and small quantities of water are added until equal volumes exactly correspond. All these solutions are kept in tightly-stoppered bottles.

The method of procedure is as follows:—The necessary quantity of alkali being weighed or measured, as the case may be, it is diluted with distilled water in a flask, and enough litmus is added to produce a distinct, but not too deep, blue colour. The acid from the burette is then run in until the contents of the flask have been changed to a bright red colour. In order to expel the carbonic acid, the flask is boiled until the blue colour reappears; the acid solution must now be run in, a few drops at a time, with continued boiling, until, by the addition of a single drop, a distinct pink colour is produced. In order to obtain a very accurate result, it is well to run in an excess of acid, boil the liquid well, and then add, drop by drop, the standard alkaline solution until the liquid suddenly changes from pink to violet-blue. The quantity of the alkaline solution required to effect this change is subtracted from the volume of acid originally run in, and the exact volume of standard acid required to neutralize the amount of alkali previously taken from analysis is thus determined at once.

The converse of this process may be applied to the estimation of the amount of acid contained in acid liquids or mixtures (see Acidimetry).

Mohr recommends the use of oxalic acid instead of sulphuric or hydrochloric, because it is more readily weighed than a liquid, and because its solution may be kept for a much longer period than these without undergoing change in strength. The weight required is 63 *grm.* per *litre* of water.

In making determinations of the quantity of alkali contained in samples of crude carbonate of potash and soda by gravimetric [weight] analysis, the apparatus used in acidimetry, and shown in Fig. 1, may be employed. The weighed carbonate is dissolved in warm water in the flask A, and a quantity of acid, more than sufficient to neutralize the alkali, is placed in the short tube in the interior. The apparatus is then weighed, and the tube *d* closed by a plug of wax; the flask is tilted gently, so as to cause the acid to flow into the flask upon the carbonate. Carbonic acid is thus evolved, and the apparatus should be gently warmed until the evolution of gas completely ceases. When this is the case, the plug is removed, air is drawn through, and the whole is again weighed. The loss indicates the quantity of carbonic acid evolved, from which the amount of real carbonate contained in the sample may be calculated at once. The acidity of the solution, at the conclusion of the test, should be determined by adding a drop of litmus solution; if it be not acid, more acid must be added, and the operation repeated.

Fresenius & Will's apparatus, shown in Fig. 2, may also be employed in making alkalimetrical estimations, the same as in acidimetry. The alkali to be tested is carefully weighed, and dissolved in water in the flask A; concentrated sulphuric acid is placed in the flask B, and the apparatus is accurately weighed. After closing the end of the tube *c*, suction is applied to the tube *a*, so as to draw over a small quantity of air from A into B through the tube *b*; on withdrawing the lips, the pressure of air forces a little of the acid over into A, by which means the alkali is decomposed. This is continued until the evolution of carbonic acid ceases, when heat is applied gently for a few moments. Air is then drawn through, and the apparatus is cooled and weighed. The loss in weight gives the amount of carbonic acid evolved, as in the previous case.

ALBUMEN, an organic nutritive principle, is a constituent of all animal fluids and solids. The white of eggs contains 12 per cent. of albumen, and the fluid portion of blood [serum] 7 per cent. It occurs also in the flesh, in the brain, and more or less in all serous fluids. Fibrin also may be regarded as coagulated albumen. It occurs in the vegetable kingdom, in the sap or juice of many plants, such as the potato, turnip, carrot, cabbage, in the green stem of peas, in the seeds of the cereal grasses, and in many nuts.

There are two modifications of albumen, soluble and insoluble. The former occurs in the animal body, but the insoluble modification may readily be prepared from it by the action of heat. This property of becoming insoluble, or "coagulating," as it is termed, by the action of heat, is especially characteristic of this substance, and constitutes its chief value for technical applications.

Albumen contains carbon, hydrogen, oxygen, and nitrogen, together with traces of sulphur and phosphorus. Its chemical composition is:—

	Per cent.
Carbon	53·3
Hydrogen	7·1
Oxygen	22·1
Nitrogen	15
Sulphur	1·8
Phosphorus	trace
	100·0

Animal albumen is always associated with certain inorganic salts and free soda. It exists in the animal body in solution, in the form of an alkaline albuminate. If the white of eggs, or the serum of blood, or any animal liquid containing albumen be incinerated, the residue is chiefly carbonate of soda. This alkali may readily be removed, and the albumen rendered insoluble, or coagulated, by the action of heat. Exposed to a gentle heat, soluble albumen gives off a peculiar, characteristic odour. It can be dried at 104° F. (40° C.) without being rendered insoluble, and in this form is usually met with in commerce. On raising the heat to 130° F. (54° C.), white fibres of insoluble albumen begin to appear; at 160° F. (70° C.) it becomes a solid, jelly-like mass; and at 212° F. (100° C.) it dries up, turning yellow and brittle, like horn. When in this condition, 5 times its weight of water will redissolve it, bringing it once more to its original consistency. The only change which the albumen undergoes during the process of coagulation is the removal, by the hot water, of the alkali and soluble salts. Its chemical composition remains the same throughout.

Albumen of good quality is recognized by its transparency when in flakes, by its flavour not being disagreeable, and by leaving no odour of putrefaction. Constantly stirred in cold water, it should dissolve entirely. For practical purposes, it is best dissolved in warm water, at a maximum temperature of 113° to 122° F. (45° to 50° C.). The albumen should be added gradually, and the liquid constantly stirred. The water should on no account be added to the albumen. The liquid, after straining through a fine silk sieve, is usually mixed with a small proportion of ammonia, turpentine-oil, &c., in order to prevent frothing, and make it work smoothly. Turpentine also tends to prevent putrefaction, but an addition of about 1 per cent. of arsenious oxide is said to be the best preservative. Commercial albumen is very liable to adulteration (especially the dearer egg-albumen) with gum-arabic, dextrine, flour, sugar, &c. Allen gives some very useful tests for commercial samples in the *Analyst* for December 1882, pp. 210–11.

The uses of albumen are numerous and important. For clarifying wines and liquors it cannot easily be replaced; in sugar refining it is extensively used for a similar purpose. In dyeing and calico printing it holds a high place as a mordant for "fixing" certain colours; in this sphere it has a competitor in caseine, which the trade have misnamed "lactarine." Photographers use large quantities of albumen for preparing paper for silver-printing. In varnish making, both egg- and blood-albumen are employed; for this purpose they are sometimes replaced by caseine, and will probably soon have to compete also with legumine (vegetable albumen).

According to Wagner and Witz, albumen which has been coagulated (rendered insoluble) may be restored to the soluble (coagulable) state by means of treatment with pepsin. By Wagner's plan, 12 to 13 oz. of insoluble albumen are placed in contact with 1 oz. of calf's stomach, cut into little pieces, and distributed through 1¾ pints of water, previously treated with ⅓ oz. concentrated hydrochloric acid, and having a temperature of 100° F. (37½° C.). After 24 to 36 hours' standing, the whole is passed through a fine sieve, and the filtrate neutralized with ammonia.

Witz uses sheep's stomach, and over 4 oz. of dry insoluble albumen to 1¾ pints of acidified water, digesting for 40 hours at a temperature of 95° to 104° F. (35° to 40° C.), whereby about half the albumen goes into solution. This portion is removed by filtration, and the insoluble residue is again treated in the same manner to yield a second portion of soluble albumen. Pigs' stomachs are even more active than sheep's. The solution of albumen obtained by Witz is odourless and colourless, and, after the neutralization with ammonia, coagulable either by heat or alcohol. More, it does not gelatinize, even after long standing. The addition of the hydrochloric acid is essential to success with the pepsin processes. Indeed, dilute hydrochloric acid (1 part of 1·169 sp. gr. in 100 water) alone, at a temperature of 100° F. (38° C.), after some days effects the solution of insoluble albumen, affording a solution which will coagulate on boiling.—(See *Dingler's Jl.*, ccxix. 166–71.)

Blood-albumen occurs in commerce in various forms. The lowest quality is packed in casks in the liquid state, and consists merely of blood which has been defibrinated by whipping. The purer forms of blood-albumen are prepared from the blood of slaughtered animals, which after coagulation, is filtered: 5 oxen, or 20 sheep, or 34 calves are said to yield the same quantity of dry albumen—viz. 2 lb. In producing blood-albumen for commerce, the objects borne in mind are the attainment of a substance whose solution is free from colour, possesses perfect coagulation, and which is cheap. The superior price of egg-albumen has led to various attempts to prepare a blood-albumen of a similar whiteness and quality. In these attempts, animal charcoal, incipient coagulation, air rendered ozonic by means of electric induction, have severally been employed, but none proved capable of producing an albumen at all comparable in value to egg-albumen.

Campe recommends that the dishes and sieves for the separation of the serum should be in close proximity to the slaughter-houses, since the retarding of that separation is almost sure to be followed by more or less coloration of the serum, which, of course, leads to a dark-hued albumen.

The blood clot is cut into small lumps, placed on the sieves, and left there for 40 to 48 hours. The first portions of the serum which pass through are always red, but after the lapse of about an hour, the percolating liquid shows a clear yellow colour, the tinge varying, according to the variety of the cattle, from deep gold to that of pale hock. After 48 hours, the clear serum is drawn off, care having been taken that the lowest layer containing the red blood-corpuscles is kept back. About 25 to 30 per cent. of serum is thus obtained from ox-blood, and this raw material can be manufactured into either the so-called "natural" albumen, without gloss, or the "patent" glossy albumen.

In making natural albumen, ¼ lb. of oil of turpentine is added to 100 lb. of serum, and the whole is whipped for an hour with apparatus similar to the dasher of an old-fashioned churn. The turpentine not only bleaches the serum and extracts the grease, but also helps to preserve it. It is allowed 24 to 36 hours to settle, when the clear serum is drawn off from the sediment. The drying is done in japanned iron dishes 1 ft. long, 6 in. wide, and ¾ in. deep. The temperature is at first about 122° F., and is raised to nearly 135° F. (57° C.) for 2 hours, after which it is allowed to fall to 115° or 120° F. (46° to 49° C.). The drying occupies about 36 hours.

The manufacture of "patent" albumen differs from the above in the use of acids. To 100 lb. of serum are added 7 dr. sulphuric acid, mixed with 6¼ oz. concentrated acetic acid, and 6 lb. water; ¼ lb. oil of turpentine is next mixed with it, and the compound is whipped for an hour. After settling for a day or more, the clear liquid is poured off, neutralized with ammonia, and dried as before. About 10 lb. of serum will yield 1 lb. of dried blood albumen.

Both these preparations are called "primary" products, as distinguished from the "secondary" and "tertiary" products obtained from the residues left in the dishes after the drawing off of the pure serum and from the clot on the sieves. The albumen from the last-named source is, of course, of very inferior quality, but is largely used in sugar refining.

Blood-albumen, of good quality, is manufactured near St. Petersburg, in an establishment close to the central slaughter-house, so that the serum is obtained quite fresh, and is brought at once into the drying rooms. The blood-albumen produced in other parts of Russia is not of so good a quality as that prepared in St. Petersburg. There are three large blood-albumen works in Moscow, which are, however, situated at some distance from the slaughter-houses. The prices vary a good deal—from 15 to 30 *rubles* (of 2*s.* 6*d.*) and even 40 *rubles*, per *pud* (36 lb.). The St. Petersburg brand is sold always 5 to 10 *rubles* higher than the others. St. Petersburg produces yearly 4000, Moscow 2000, and the other towns about 1300 *puds*, so that the whole production is about 7300 *puds*. In the albumen factories at Buda-Pest, 3000 lb. of blood are expected to yield about 110 lb. of albumen, at a cost somewhat less than ⅓ that of egg-albumen. The manufacture there is extensive.

The manufacture of blood-albumen is pretty largely carried on in this country of recent years, and is the subject of some interesting remarks from Dr. Ballard, especially with regard to the noxious effluvia arising from it. The trade consists in the separation of the serum from blood-clot, and the drying of the former into transparent flakes of a reddish-yellow colour, but varying in depth of colour according to the quality of the serum from which they are made. Blood-clot is absolutely worthless for the purposes of this trade if it be not fresh. The more recently the blood has coagulated, the more valuable it is for albumen making. Hence the blood-albumen makers effect arrangements for the speedy collection of blood from butchers and town abattoirs, and it is dealt with immediately on its arrival at the works. Sometimes the first process, that of "separation" of the serum from the clot, is carried on in some part of a public abattoir. The serum is, in such cases, sent away in casks to the establishments where it is dried.

The blood arrives in the shallow iron vessels in which it is caught from the slaughtered animals, or in casks. The clot is immediately taken out and carefully sliced (when it arrives in shallow vessels it is sliced before removal from them), and the slices are arranged upon iron strainers, each with a pan beneath to receive the serum which flows out as the clot continues to contract spontaneously. The season of the year governs the time during which this draining is prolonged. In summer it is continued for about 12 hours, but in winter for 18 or 24 hours. The strainers, each with its pan beneath, are arranged on racks in a building which is so constructed as to be kept as cool as possible. It is also important that the building should be in such a locality as to be free from vibration caused by the passage of heavy vehicles or railway trains. From the pans, the serum is, in the best works, transferred into a settling tank, where it remains about 2 days until all the red colouring matters, &c., which may be in suspension having been deposited. At some works, where an inferior article is made, the highly-coloured serum which comes with the clot in the casks is dried, and after the clot has been drained, it is put into a cask (from which the head has been taken out) to separate in bulk still further, and the dark serum which exudes is run off for use.

The serum is then transferred into a series of shallow iron trays, which are arranged upon racks in a chamber heated with steam pipes to a temperature of about 120° F. (49° C.). When it is quite dry and brittle, the albumen is scraped from the trays, and taken to the warehouse to be sorted and packed. The waste clot usually is sent away either to the manure maker or to the blood driers, but is sometimes dealt with on the spot.

The well-known faint odour of blood always pervades an establishment of this kind, and is especially marked in the drying chamber; but it does not pass beyond it in any such way as to cause a nuisance, unless the manufactory be very badly conducted. The two ordinary sources of nuisance from blood-albumen works consist:—(1) In the effluvia of putrid blood arising from the exhausted clots retained on the premises prior to removal. (2) In the general disagreeable faint smell proceeding from the yard and premises, especially when due cleanliness is not observed. (3) In effluvia from other and further processes, such as blood-boiling or blood-manure making, carried on upon the premises. As to the remedies for nuisances, Dr. Ballard observes: (1) It is a practice in some works to throw the exhausted clot into a clot-bin, where it is left until removal. But now, in the best works, the clots are at once put into moderately sized casks, through a sufficiently large opening at one end, which, when the cask is full, is closely fastened down with a cover secured by screws. (2) Such works as these require to be conducted in a very cleanly manner. The yard should be well paved with stone, set so that no water may lodge upon it, and so that any offensive liquids that may reach it may not form pools, but flow readily away to the drain inlet. It should be kept at all times well swept up, and should be daily washed down with water. The separation room and the room in which the clots are sliced, when very near inhabited houses, should be closed in on all sides and ventilated at the roof, as recommended for slaughter-houses, and they should be well and evenly paved. The best kind of pavement for such a room is one of cement. Flagstones are apt to crack or loosen, and the pavement to become uneven, and thus liable to retain pools of liquid matters, or to the insinuation of these liquids between and beneath the stones. Nothing can be more objectionable than a wooden floor. The floors should be frequently scrubbed and cleaned, all the vessels and implements used ought to be regularly cleansed, and the whole interior of the buildings periodically lime-whited. The vapours from the drying chambers should be discharged at an elevation greater than that of adjoining houses.

A. H. Allen states that the qualities of blood-albumen as made by the leading firms are "refined," "prime," "No. 1," "No. 2," and "black." "Refined" is made from highly rectified serum, and is of a dirty-yellow colour; like "prime," it is employed as a mordant for printing delicate colours. "No. 1" is darker-coloured and of less value, though suitable for all ordinary printing purposes. "No. 2" is made from the second drainings of the serum, which, after the clear top serum has been siphoned off is more or less tinged with red, and consequently only fit for printing dark colours; as a rule, it also contains some insoluble matter, which is objectionable. "Black albumen" or dried blood is obtained from the last portions of serum, and is almost black in colour. It is not used in calico-printing, but finds applications in sugar refining, and Turkey red dyeing.

C. T. Kingzett has patented (No. 2630 of 1876) a process of bleaching blood-albumen, and at the same time preserving it from putrefaction, by aerial oxidation of certain hydro-carbons in the presence of the albuminous solution to be bleached at a temperature below the coagulable point. Thus, if turpentine be employed, peroxide of hydrogen is formed on the one hand (and this bleaches the albumen), while other substances are simultaneously produced in sufficient quantity to preserve the mass from putrefactive decomposition. During the past 4 years this process has been worked on serum and dark-coloured scales, producing solutions containing 2 to 4 lb. of albumen per gallon. The existence of the salts present in serum does not interfere with its photographic applications.

Kingzett also experimented in the direction of utilizing flesh, casein, &c., as a source of albumen. And Portheim has patented (No. 1686 of 1881) a process with the same object. The difficulty to be overcome is to retain the coagulability of the albumen, on which its value entirely depends.

Egg-albumen.—Albumen may be prepared in a pure state from white of eggs, by the following method:—The white of eggs is beaten up well with water and filtered. To the filtrate is added a small quantity of sub-acetate of lead, in order to remove the mineral substances. The whole of the albumen is now precipitated as albuminate of lead. This is stirred up with water, and carbonic acid gas is passed through, by which the albuminate of lead is decomposed; carbonate of lead is precipitated, and the albumen remains in solution. The carbonate of lead is now filtered off through paper which has been washed with dilute acid. Traces of lead still remain, and to remove these the filtrate is treated with a few drops of aqueous sulphuretted hydrogen, and gently heated. The first flocks of albumen which appear, retain the whole of the lead as sulphide. This is filtered off, and the filtrate evaporated gently in a basin, the residue consisting of pure soluble albumen.

The manufacture of egg-albumen in the neighbourhood of Moscow is carried on in the houses of the country people, who bring their product to the town in small quantities. The albumen is generally roughly prepared and of bad appearance, and often spoils. But egg-albumen is produced on a manufacturing scale in the neighbourhood of Korotscha, the largest establishment there numbering 60 to 70 workwomen, and having used 8 million eggs, producing about 1500 *pud* (of 36 lb.) albumen, of the value of 60,000 *rubles*. In the same place are two smaller establishments, one employing 20 to 30 women, and treating about 2½ to 3 million eggs yearly. In 1880, the production did not come up to the demand, on account of the scarcity of eggs, and the price rose from 37 to 40 *rubles* (of 2*s.* 6*d.*) per *pud* in 1879, to 54 to 55 *rubles* in 1880. The yolks of the eggs are mostly exported to Germany, where they are used in the preparation of glove-leather, sometimes under the name of "egg-oil."

In preparing egg-albumen there is considerable difficulty in completely separating the white from the yolk. Campe recommends that the whites should be refined by whipping up with oil of turpentine and a trace of acetic acid, and allowing the whole to stand for 25 to 36 hours, when the oil floats on the surface, and carries impurities with it. From a pecuniary point of view, this process does not appear to be advantageous, at least not in Moravia, Silesia, and Saxony. An important condition for the profitable production of albumen from eggs is the possibility of easily disposing of the yolk. Since this cannot always be done in the neighbourhood of albumen factories, and as transporting the material to a distance is apt to produce decomposition, it is necessary to add to it some antiseptic substance. Campe finds a solution of soda arsenate in glycerine, to which some salt is added, best suited for the purpose. Carbolic acid, soda hyposulphite, &c., have been more or less successfully tried, but found objectionable on the part of tanners and glovers, who are the chief consumers of yolk of eg The former imparts to the leather its penetrating smell, the latter produces stains.

Desiccated egg-albumen is now well-known in the market in the form of a powder, costing about 1s. per 3½ oz., this quantity representing the whites of about a score of eggs. For use in photography, 3 teaspoonfuls of cold water added to every ½ teaspoonful of powder represent the normal consistency of egg-albumen.

According to Berg's process for preserving egg-albumen for photographers, the whites, separated from the yolks, are evaporated to dryness in zinc or porcelain basins, at a temperature of 113° F. (45° C.), the operation being conducted *in vacuo*, to hasten the evaporation. The solid albumen thus obtained is reduced to powder, which, if kept perfectly dry, may be preserved for a long time without alteration, and is applicable to all ordinary purposes.

Fish-albumen is not unknown in the market, and may be recognized by its fishy odour. Hilman's process for preparing it is as follows:—The crushed spawn is macerated in sufficient water to dissolve out the albumen. The albuminous water is separated by filter press, and evaporated in a vacuum-pan nearly to dryness. The thickened mass is then dried on drying-floors, salicylic acid, in the proportion of 1 to 20, being added as a preservative. There are difficulties in the way of freeing fish-albumen from accompanying substances, which reduce its value.

Vegetable-albumen is most easily prepared from potatoes, by cutting them into slices, covering them with very dilute sulphuric acid (2 per cent.), leaving them 24 hours, then adding fresh potatoes, and repeating the operation once more, afterwards neutralizing with potash and boiling. A considerable quantity of albumen is then deposited in thick white flocks. It can also be made from wheat-flour and from oleaginous seeds. Kingzett's and Porthein's processes, briefly alluded to under "Blood-albumen," are equally applicable to gluten, the protein of worts, &c. The latter inventor takes 100 lb. of the albuminous matter, ground up and washed with water, and dissolves it in 200 to 250 lb. of water, in which has been previously dissolved 4 lb. of caustic soda or potash at 194° to 212° F. (90° to 100° C.). To the solution thus prepared he adds 4 per cent. of a solution containing 40 per cent. of glycero-sulphate or glycero-phosphate of calcium, or 4 per cent. of a mixture of calcic chloride and an alkaline salt of citric, tartaric, or meta-phosphoric acid. The mixtures are "scaled" in the usual way.

No commercial attempt seems to have been made to prepare vegetable-albumen from the waste of starch factories and oil-presses, though there would seem to be no insuperable difficulty. The subject is well worth attention, for the raw materials would be cheap as compared with eggs, blood, or fish-roes, and, moreover, of no value for alimentary purposes. This appears to be the only promising direction in which an increased production of what has become an indispensable article can be looked for.

ALCOHOL. — Alcohol does not occur in nature, but is the product of the decomposition of glucose [uncrystallizable sugar], which, under the influence of certain nitrogenous substances called "ferments," is split up into alcohol and carbonic anhydride, the latter being evolved in the form of a gas, while the former remains behind mixed with water, from which it is separated by distillation. All substances containing sugar, or substances which can be converted into sugar (e.g. starch), are "alcoholizable," or capable of yielding alcohol. The manufacture of alcohol on a commercial scale is too large a subject for discussion here, and may best be studied in such works as Spons' Encyclopædia (pp. 192–229), but the chief varieties deserve a brief notice. In all cases (except caustic alcohol) the same operations have to be carried out, viz. (1) fermentation, to convert the glucose into alcohol; (2) distillation, to separate the water and alcohol; (3) and these are followed by rectification. Fermentation and distillation are described in another section, but rectification will be discussed at the end of the present article.

Caustic Alcohol.—This term is commonly applied to sodium ethylate, a product formed by the decomposition of absolute alcohol with pure metallic sodium, the chemical formula being $C_2 H_5$. Na O, or alcohol which has had one atom of its hydrogen replaced by one of sodium.

Dr. Richardson gives the following directions for preparing a solution of the proper strength for use:—Place ½ fl. oz. of absolute alcohol in a 2-oz. test-tube surrounded by a water-bath at 50° F. (10° C.); add sodium in small pieces to the alcohol so long as gas is given off; then raise the temperature of the bath to 100° F. (38° C.), and add more sodium so long as it continues to dissolve; lastly, cool to 50° F. (10° C.), and add ½ fl. oz. more absolute alcohol. There are several obvious objections to this method, in the time occupied, the long exposure to the air of such hygroscopic bodies, and the varying strength of the product. To remedy these, Dr. L. H. Smith proposes that the solution be made from a weighed amount of sodium, with as little exposure as possible. He finds the average weight of sodium used for making 23 *cc.* to be 0·635 *grm.*, forming 1·877 *grm.* of sodium ethylate; this dissolved in 20 *cc.* of alcohol would give a solution containing 9·385 per cent. To make a 10 per cent. (nearly) solution would need 0·68 *grm.* sodium for 20 *cc.* absolute alcohol, and 2·01 *grm.* of the ethylate in 20 *cc.* Dr. Smith prepares a solution of 10·05 per cent. strength as follows:—20 *cc.* of absolute alcohol is placed in a test-tube, closed with a perforated cork, into which a small tube drawn to a fine point has been inserted; the test-tube is placed in a bath of ice-water; 0·68 *grm.* of sodium is weighed out, cut into 3 pieces, and immediately replaced in the hydrocarbon oil in which it is kept; one piece of the sodium is quickly dried of the oil, dropped into the alcohol, and the cork replaced in the test-tube. It rapidly dissolves, when the second piece is added, and finally the third, observing that as the solution becomes stronger and the reaction slower, the test-tube is removed from the bath at intervals, to allow the temperature to rise, and hasten the solution. The finished solution is immediately transferred to small bottles and kept from the light.—(*Pharm. Jl.*, [3] xii. 995)

Fruit-alcohol.—The most important juicy fruit (cereals or grain will be separately considered) affording alcohol is undoubtedly the grape. For this purpose the just ripe unbruised grapes, in bunches, are crushed in perforated boxes, and the exuding juice is collected in vats. The juice and the refuse ("marc") are fermented either separately or together. The resulting alcoholic liquid is distilled to afford genuine brandy or wine alcohol. Among other fruits that have been similarly utilized are apricots, cherries, peaches, currants, gooseberries, raspberries, strawberries, and figs. Acorns, freed from the shells, finely ground, mashed with malt, and allowed to ferment, yield an alcohol said to be equal to that from grain. Horse chestnuts might be turned to a similar useful account.

Grain-alcohol.—The cereals contain an amylaceous (starchy) substance, which under the influence of diastase is converted into fermentable sugar. The following table shows the possible yields from different grains:—

			Pints pure alcohol.
100 lb.	rice	give	24½
„	wheat	„	22½
„	rye	„ .. .	19½
„	barley	„	17½
	buckwheat		17½
	maize		17½
	oats		15½

Rice, maize, wheat, sorghum, and rye are most largely used; barley and buckwheat are added in some proportions; oats are too dear to be employed for any purpose but lending an aroma to the product of other grains.

The processes necessary to prepare grain for fermentation are:—

(1) Steeping in water for 30 to 40 hours, or until the grains yield readily when crushed between the fingers.

(2) Germination, or spreading the drained grain in beds 2 or 3 ft. thick in a "malthouse," kept at 53½° F. (12° C.); here it heats, and soon begins to germinate ("grow out"), this operation being finished when the rootlets have attained ⅔ the length of the grains, which may require 8 to 15 days. Care is needed in regulating the temperature, and the mass wants turning every 6 to 8 hours before germination, and every 3 to 5 hours afterwards, the temperature of the grain being kept at 59° to 61° F. (15° to 16° C.).

(3) Drying the germinated grain ("malt") in layers of about 12 in. in a "kiln" at a temperature commencing at 95° F. (35° C.), rising to 131° to 140° F. (55° to 60° C.), and finishing at 176° to 194° F. (80° to 90° C.).

(4) Grinding more or less finely.

(5) Mashing the malt and unmalted grain with water at 95° to 100° F. (35° to 38° C.), to liberate the saccharine fermentable matters from the starch of the unmalted grain by the action of the diastase generated in the germination of the malt.

(6) Infusion of the mass by adding boiling water till the temperature reaches 140° to 158° F. (60° to 70° C.), then allowing to stand for 4 hours with the heat never below 122° F. (50° C.), to convert the liberated starch into glucose.

(7) Fermentation of the "wash," previously cooled down to 68° to 79° F. (20° to 26° C.), in covered vats, by adding about 10½ pints of liquid or 7 lb. of dry brewer's yeast for every 250 lb. of grain used, and leaving for 4 or 5 days.

Grain alcohols are chiefly represented by gin and whiskey.

Molasses-alcohol.—Rich molasses (the impure uncrystallizable sugary product separated from raw sugars by the process of refining) contains as much as 50 per cent. of sugar. The drainings and skimmings obtained on cane estates in the preparation of sugar are included under the same term. When diluted with water, fermentation sets in rapidly. Molasses from beet-sugars are usually alkaline, and first need acidification, about 4½ lb. of concentrated sulphuric acid being added to each 22 gal. of molasses, previously diluted with 8 to 10 volumes of water. Fermentation is hastened by the aid of a little brewers' yeast, or other natural ferment; it begins in 8 to 10 hours and lasts over 60.

Cane-molasses alcohol is familiar as rum, while the beet-molasses article is generally rectified down to almost pure spirit.

Moss-alcohol.—Large quantities of alcohol are distilled in Sweden and Russia from reindeer moss (*Cladonia* [*Cenomyce*] *rangiferina*) and Iceland moss (*Cetraria islandica*). The yield is said to be as great as from good grain, while the supply of material is abundant and cheap.

Root-alcohol.—A number of roots and tubers, including beet, potatoes, carrots, turnips, asphodel, madder, and chicory, have been availed of for the manufacture of alcohol, the most important being beets and potatoes.

Beets contain about 10 per cent. of sugar, which can be converted into alcohol in several ways, chiefly:—(1) rasping and pressing the roots and fermenting the expressed juice; (2) macerating in hot water; (3) direct distillation.

(1) The roots are washed, rasped (grated), and pressed, yielding 80 to 85 per cent. of juice; this is heated to about 82½° F. (28° C.), and run into fermenting-vats; here it is acidulated with not more than 6¼ lb. of sulphuric acid to every 1750 pints of juice, to neutralize the alkaline salts present, and hinder viscous fermentation. Alcoholic fermentation is assisted by the addition of about 1 oz. of yeast previously mixed with a little water to every 100 pints of juice, the external temperature being carefully maintained at 68° F. (20° C.). The alcohol produced by this process is the best but dearest, requiring most plant and labour.

(2) In the maceration process, the washed roots are cut into slices, having a width of less than ½ in., a thickness of $\frac{1}{25}$ in., and a variable length; the slices are covered with boiling water in a wooden or iron macerator for 1 hour, the water containing 1 lb. sulphuric acid for every 50½ lb. of beet. The partially saturated water is next drawn off into a second vat, where more slices are added, and maceration takes place for 1 hour; and finally into a third likewise, after which it goes to the fermenting-vat. In mild weather the juice will be at about the right heat for fermentation, say 71½° to 75¼° F. (22° to 24° C.), but in very cold weather reheating may be necessary. The fermentation is similar to that of pressed juice, and is usually complete in 24 to 30 hours. The alcohol thus obtained is inferior but much cheaper.

(3) Laplay's method of direct distillation of the roots is not generally employed. Operations are conducted in vats of 100 bushels' capacity, and a charge consists of 2500 lb. of the sliced roots, inclosed in porous bags, and immersed in 440 gal. of acidulated water, with the temperature maintained at about 77° to 80½° F. (25° to 27° C.). The addition of a little yeast starts the fermentation, which lasts about 24 hours. Distillation is conducted in a simple apparatus, leaving the slices available as cattle-food.

Potato-spirit is made chiefly in Germany, and its manufacture has now assumed considerable importance. Potatoes contain 16 to 20 per cent. of starch, which is capable of being converted into glucose by the action of sulphuric acid or of malt. Three principal methods of effecting the saccharification are in use: (1) the potatoes are baked, and then crushed into pulp; (2) rasped to bring about the same result; (3) the starch may be extracted and converted into sugar afterwards.

(1) In the first method are several operations, viz. cooking the potatoes; crushing them; converting the starch into sugar by means of malt; and finally, fermentation and distillation. The operation of "cooking" is carried on in a boiler set in brickwork, surmounted by a tun made of oak staves. The bottom of the tun, which must be of solid wood, is perforated with a number of small square holes to give admittance to the steam from below. The potatoes placed in this tun are rapidly cooked by the ascending steam; they are then withdrawn and crushed into a thick pulp between two rollers, commonly made of oak, and placed below the level of the tun. As the potatoes swell considerably during the steaming, the tun should never be completely filled. The pulp is placed in a vat, holding 660 to 880 gal., in which the saccharification takes place. About 2500 lb. of the crushed potatoes and 175 lb. of broken malt are introduced, and immediately afterwards water is run in at a temperature of about 86° to 104° F. (36° to 40° C.), the contents being well stirred with a fork meanwhile. The vat is then carefully closed for ½ hour, after which boiling water is added until the tem-

perature reaches 140° F. (60° C.), when the whole is left for 3 or 4 hours. The process of fermentation is conducted in the same vat. Alternate doses of cold and boiling water are run in upon the mixture, until the quantity is made up to 700 to 770 gal., according to the size of the vat, and so as finally to bring the temperature to 75¼° to 78¾° F. (24° to 26° C.). Liquid brewer's yeast (4½ to 5¼ pints) is added, and fermentation speedily sets in. This process complete, the fermented pulp is distilled in the apparatus devised by Cellier-Blumenthal, for distilling materials of a pasty nature; the product has a very unpleasant odour and flavour.

(2) By rasping the potatoes, the expensive operations of cooking and separating the starch are avoided. In this operation, the washed potatoes are thrown into a rasping machine similar to those employed in sugar manufactories. If 2500 lb. of potatoes be worked at once, the vat has a capacity of 484 to 550 gal., and a perforated false bottom carrying a layer of straw. The charged potatoes are allowed to stand for ½ hour in order to get rid of a portion of their water. After this, 219 to 262 gal. of boiling water are run in, and then 175 lb. of malt are added; the whole is stirred up and left to macerate for three or four hours. This done, the liquid is drawn off from beneath into the fermenting-vat; the pulp is drained for ¼ hour, and the drainings are added to the liquor previously run off. Boiling water (109 gal.) is run in upon the pulp, which is again stirred up energetically. After remaining some little time, the water is again drawn off, the pulp drained and washed anew with 109 gal. of cold water, with agitation. This is again drawn off, and the whole of the water with the drainings is mixed up in the fermenting vat. Yeast (5 lb.) is added, and the contents of the vat are left to ferment. Only the liquor is fermented by this process, but the spirit yielded is nearly as unpleasant to taste and smell as that obtained by process No. 1.

(3) The only means of obtaining alcohol of good quality from the potato is to extract the starch and convert it into sugar separately. The saccharification of the starch is effected either by sulphuric acid or diastase, the latter being decidedly preferable. In a vat of 660 gal. capacity are mixed together 220 gal. of cold water, and 1250 lb. of dry or 1875 lb. of moist starch. The mixture is well agitated, and 247 gal. of boiling water are run in, together with 180 to 200 lb. of malt; the whole is stirred up energetically for 10 minutes, and then left to saccharify for 3 or 4 hours. The saccharine solution obtained must be brought to 6° or 7° B. at a temperature of 71½° to 75¼° F. (22° to 24° C.), and 17½ oz. of dry yeast are added for every 290 gal. of must. Fermentation is soon established, and occupies usually about 36 hours. After remaining at rest for 24 hours, the must is distilled; 250 lb. of starch ought to yield 8 to 9 gal. of pure alcohol, or 9 to 10 gal. of alcohol at 90°.

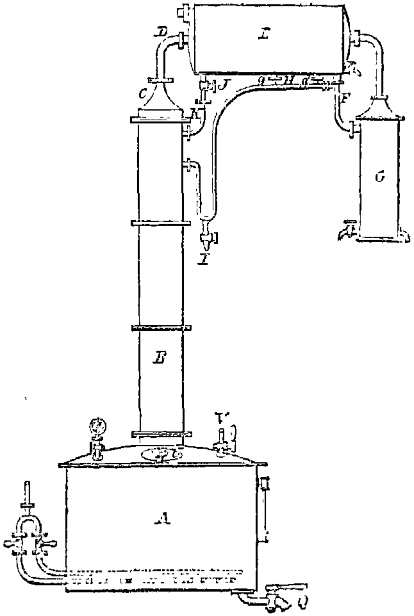
The spirit obtained by treating the *yam* or *sweet potato* in a similar manner is said to be far superior to that yielded by the common potato.

According to *Erfindungen und Erfahrungen*, *chicory* seems likely to become of importance as a source of alcohol. The root contains an average of 24 per cent. of substances easily convertible into sugar, and the alcohol obtained by its saccharification, fermentation, and distillation is characterized by a pleasant aromatic flavour and great purity.

Rectification.—The product of the distillation of alcoholic liquors, termed "low wine," does not usually contain alcohol in sufficient quantity to admit of its being employed for direct consumption. Besides this, it always contains substances which have the property of distilling over with the spirit, although their boiling-points, when in the pure state, are much higher than that of alcohol. These are all classed under the generic title of "fusel-oil": owing to their very disagreeable flavour and odour, their presence in spirits is extremely objectionable. In order to remove them, the rough products of distillation are submitted to a further process of concentration and purification. Besides fusel-oil, they contain other substances, such as aldehyde, various ethers, &c., the boiling-points of which are lower than that of alcohol; these must also be removed, as they impart to the spirit a fiery flavour. The whole process is termed "rectification," and is carried on in a distillatory apparatus. Heat is first applied gradually, in order to remove the most volatile impurities, and to concentrate them in the first portion of the distillate. When the spirit coming over possesses no objectionable odour, it is caught separately as long as it is of sufficient strength. The receiver is then changed again, and the remainder is collected apart, as weak spirit which contains much fusel-oil; the first and last runnings are then mixed together and re-distilled with the next charge. When a strong spirit is required, rectification may be repeated several times. It is customary, however, with the improved apparatus of modern times, to produce at the outset spirit containing but little fusel-oil and at least 80 per cent. of alcohol; this is then purified and concentrated in the above manner, and afterwards reduced with water to the required strength.

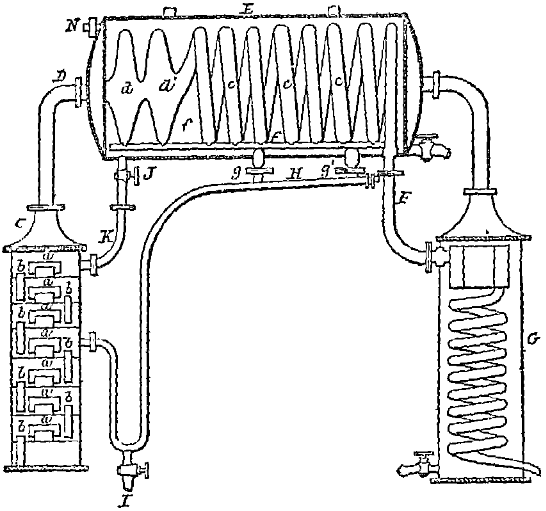
Another cause of the offensive flavour of the products of distillation is the presence of various acids, which exist in all fermented liquors; they are chiefly tartaric, malic, acetic, and lactic acids. The excessive action of heat upon liquors which have been distilled by an open fire has also a particularly objectionable influence upon the flavour of the products.

The first operation in the process of rectification is to neutralize the above-mentioned acids; this is effected by means of milk of lime, which is added to the liquor in quantity depending upon its acidity; the point at which the neutralization is complete is determined by the use of litmus paper. In the subsequent process of distillation, the determination of the exact moments at which to begin and to cease collecting the pure spirit is very difficult to indicate. It must be regulated by the nature of the spirits; some may be pure 20 or 30 minutes after they have attained the desired strength; and some only run pure an hour, or even more, after this point. The product should be tasted frequently, after being diluted with water, or a few drops may be poured into the palm of the hand, and after striking the hands together, it will be known by the odour whether the spirit



be of good quality or not; these two means may be applied simultaneously.

Fig. 4.



The process of rectification is usually carried on in the apparatus shown in Figs. 3 and 4. A is a still, $\frac{4}{5}$ full of the spirit to be rectified. The condenser E and the cooler G are filled with water. After closing the cocks F and I, the contents of the still are heated by steam, which is introduced at first slowly. The vapours of spirit given off pass above the plates *a* of the column B, and escape through C and D into the condenser E, where they are condensed on reaching the lentils *dd'*, and return in a liquid state through *f f'* and *g g'* to the upper plates of the column B. In these return pipes the liquid is volatilized, and constantly recharged with alcohol to be again condensed, until the water in the condenser is hot enough to permit the lighter alcoholic vapours to pass into the coil *c*, without being reduced to the liquid state. When this is the case, the vapours pass through F into the cooler G, where they undergo complete condensation. Great care must be taken that the heat is not so great as to permit any of the vapours to pass over uncondensed, or to flow away in a hot state; and also to keep up a constant supply of water in the cooler without producing too low a temperature; the alcoholic products should run out just cold. The highly volatile constituents of the spirit come over first, that which follows becoming gradually purer until it consists of well-flavoured alcohol; after this comes a product containing the essential oils. The more impure products are kept apart from the rest, and re-distilled with the next charge. Some hours generally elapse before alcohol begins to flow from the cooler. The purest alcohol is obtained while its strength is kept between 92° and 96° B., and the operation is complete when the liquid flowing through the vessel marks not more than 3° or 4° B.; it is better, however, to stop the still when the backing or "faints" indicate 10° B., because the product after this point contains much fusel-oil, and is not worth collecting.

In order to cleanse the apparatus—which should be performed after each working—the still A is emptied of water by opening the cock C. The contents of the condenser are then emptied in like manner by opening the cock J, through which they flow upon the plates in the column B, and wash out essential oils which remain in them. These two cocks are then closed, and the door U is removed. The water in the cooler G is then run by means of a pipe into the still A, so as partially to cover the steam-coil in the latter. After again securing the door U, a strong heat is applied, and the water in the still is well boiled, the steam evolved thoroughly cleansing all parts of the apparatus; this is continued for 15 or 20 minutes, when the heat is withdrawn and the still left to cool gradually.

The capacity of the rectifying apparatus has a good deal of influence upon both the quantity and the quality of the spirit obtained. Besides being much more difficult to manage, a small apparatus will not yield so large a proportion of spirit as a more capacious one, nor will its products be of equally good flavour. The proportion of alcohol which may be obtained from a successful rectification is very variable; it depends upon the nature of the spirit rectified, the method of extracting the sugar, and the manner of conducting the distillation; it will also be in inverse proportion to the quantity of fusel-oil contained in the raw spirit. The average loss of pure alcohol during the process of rectification is generally estimated at about 5 per cent.

Wood-alcohol [pyroligneous acid, or pyroxylic spirit] is one of the products of the dry distillation of woods, those chiefly used, stated in the order of merit, being birch, beech, elder, and oak. The seasoned and barked wood is placed in iron retorts, similar to, but larger than gas retorts, and heated to 400° to 500° F. (204½° to 260° C.) for usually to 8 hours. The slower the distilla-on can be conducted, the greater the yield of wood-alcohol, as a quick fire causes an evaporation of alcohol. The liquor from the distillation is run into pans, and left for the tarry matters to float, when they are skimmed off. The acetic acid present is neutralized by lime, and forms commercial acetate of lime. The remaining crude liquor is re-distilled, and affords crude wood alcohol. It is further concentrated by a second distillation, and then rectified, to free it from tarry impurities, traces of acetic acid, and much of its characteristic odour. (For a full account of wood distillation the reader is referred to Spons' 'Encyclopædia,' pp. 5-27.)

ALKALOIDS. — The following are some of the general methods of preparing alkaloids :—

(1) *Base insoluble in water, non-volatile, and existing in the plant in an insoluble form.* The bruised plant is boiled or macerated in water acidulated with hydrochloric or acetic acid, and the liquor, after filtration, is neutralized with an alkali (ammonia, potash, lime, or magnesia); the resulting precipitate is purified by re-solution in dilute acid, digestion with a little animal charcoal, and subsequent crystallization, or re-precipitation with an alkali; or the first precipitate is purified by dissolving once, or, if necessary, several times in boiling alcohol, which yields the pure alkaloid either on cooling or by evaporation.

(2) *Base insoluble in water and non-volatile, but existing in the plant as a soluble salt.* The bruised or sliced plant is boiled or macerated in water, and the filtered liquor is precipitated and otherwise treated as in (1).

(3) *Base soluble in water and non-volatile.* An infusion made with very dilute acid, hydrochloric or acetic, is concentrated by gentle heat, and the residual liquor is treated with potash (or concentrated solution of ammonia) and ether conjointly; after repose, the ethereal solution is decanted and evaporated. For those alkaloids which are insoluble in ether (as morphine and cinchonine), the previous process may be adopted.

(4) *Base both soluble in water and volatile.* The vegetable, in a bruised or divided state, or its extract, is alkalized with potash and distilled; the distillate is neutralized with dilute oxalic or sulphuric acid and carefully evaporated to dryness; the residue is next digested in alcohol, and the resulting tincture agitated with potash and ether, the former being in quantity just sufficient to seize on all the acid; lastly, the ethereal solution thus formed, on careful evaporation, leaves the alkaloid nearly pure. It may be further purified by cautious distillation.

As some of the alkaloids are soluble in excess of the alkaline precipitant, over-saturation should be carefully avoided, or the precipitant may be used under the form of carbonate or bicarbonate. When lime and magnesia are employed, they are boiled for a few minutes with the solution.

Aconitine.—(1) This alkaloid is obtained from the leaves of the *Aconitum Napellus.* The leaves are infused in alcohol, and the solution is treated with milk of lime, which liberates the alkaloids in solution. To the filtered liquid is added a little sulphuric acid, and the precipitated sulphate of lime is filtered off. The filtrate is evaporated until free from alcohol, when the aconitine is precipitated by an alkaline carbonate. This precipitate is re-dissolved in alcohol and the solution is decolorized by animal black, and evaporated to dryness. The residue is re-dissolved in sulphuric acid, and precipitated anew with an alkaline carbonate; the precipitate thus obtained yields pure aconitine on treatment with ether. It is deposited from this solution in a white powder, or sometimes in the form of a compact, transparent, vitreous mass.

(2) Aconite root, in coarse powder, 14 lb.; rectified spirit, distilled water, solution of ammonia, pure ether, diluted sulphuric acid, of each a sufficiency. Pour upon the aconite root 3 gal. of the spirit, mix well, and heat until ebullition commences; then cool and macerate for 4 days. Transfer the whole to a displacement apparatus, and percolate, adding more spirit, when requisite, until the root is exhausted. Distil off the greater part of the spirit from the tincture, and evaporate the remainder over a water-bath until the whole of the alcohol has been dissipated. Mix the residual extract thoroughly with twice its weight of boiling distilled water, and when it has cooled to the temperature of the atmosphere, filter through paper. To the filtered liquid add solution of ammonia in slight excess, and heat gently over a water-bath. Separate the precipitate on a filter, and dry it. Reduce this to coarse powder, and macerate in successive portions of the pure ether with frequent agitation. Decant the several products, mix and distil off the ether until the extract is dry. Dissolve the dry extract in warm distilled water acidulated with the sulphuric acid; and, when the solution is cold, precipitate it by the cautious addition of solution of ammonia diluted with 4 times its bulk of distilled water. Wash the precipitate on a filter with a small quantity of cold distilled water, and dry it by slight pressure between folds of filtering paper. (Cooley.)

Atropine.—Atropine is an alkaloid extracted from the root of the deadly nightshade (*Atropa Belladonna*). The following, according to Cooley, are the principal recognized methods of preparing the alkaloid:—

(1) Belladonna root, recently dried, and in coarse powder, 2 lb.; rectified spirit, 10 pints; slaked lime, 1 oz.; diluted sulphuric acid, carbonate of potash, of each a sufficiency; chloroform, 3 fl. oz.; purified animal charcoal, a sufficiency; distilled water, 10 fl. oz. Macerate the root in 4 pints of the spirit, for 24 hours, with frequent stirring. Transfer to a displacement apparatus, and exhaust the root with the remainder of the spirit by slow percolation. Add the lime to the tincture placed in a bottle, and shake them occasionally. Filter, add the diluted sulphuric acid in very feeble excess to the filtrate, and filter again. Distil off ¾ of

the spirit, add to the residue the distilled water, evaporate at a gentle heat, but as rapidly as possible, until the liquor is reduced to ⅓ of its volume and no longer smells of alcohol; then let it cool. Add very cautiously, with constant stirring, a solution of carbonate of potash, so as nearly to neutralize the acid, care, however, being taken that an excess is not used. Set to rest for 6 hours, then filter, and add carbonate of potash in such quantity that the liquid shall acquire a decided alkaline reaction. Place in a bottle with the chloroform; mix well by frequently repeated brisk agitation, and pour the mixed liquids into a funnel furnished with a glass stop-cock. When the chloroform has subsided, draw it off by the stop-cock, and distil it on a water-bath from a retort connected with a condenser. Dissolve the residue in warm rectified spirit; digest the solution with a little animal charcoal; filter, evaporate, and cool until colourless crystals are obtained.

(2) Expressed juice of belladonna is evaporated over a water-bath to the consistence of an extract, and then triturated in a marble or porcelain mortar with a strong solution of caustic potash; the resulting mass is digested and well agitated for some time, at the temperature of 75° to 80° F. (24° to 27° C.), with benzole, q. s.; and after repose, the benzole solution is carefully separated, and its volatile hydrocarbon is distilled off by the heat of a water-bath; the residuum in the retort is now exhausted with water acidulated with sulphuric acid, and the resulting "acid solution," after filtration, precipitated with carbonate of soda; the precipitate is crude atropine, which is collected on a filter, pressed between folds of bibulous paper, and dried; after which it is purified by one or more re-solutions in alcohol, and crystallizations, which may or may not be modified in the manner noticed. The proportion of potash should be about 1 dr. to every quart of the expressed juice. An excellent and economical process. The product is 0·8 to 4 per cent. of the weight of the plant from which the juice has been obtained.

(3) Belladonna root (fresh-dried and coarsely powdered) is exhausted by alcohol (0·882 sp. gr.); slaked lime (1 part for every 24 of the dried root employed) is then added to the tincture, and the whole digested, with agitation, for 24 hours; sulphuric acid is next added, drop by drop, to slight excess, and, after filtration, rather more than ½ the spirit is removed by distillation; a little water is now added to the residue and the remainder of the alcohol evaporated as quickly as possible by a gentle heat; after again filtering, the liquid is reduced by further evaporation to the $\frac{1}{12}$ part of the weight of the root employed, and a concentrated solution of potash dropped into the cold liquid (to throw down a dark greyish brown matter), carefully avoiding excess, or rendering the liquid in the slightest degree alkaline; in a few hours, the liquid is again filtered and carbonate of potash added as long as a precipitate (atropine) falls; after a further interval of 12 to 24 hours, this precipitate is collected and drained in a filter, and after pressure between folds of blotting-paper, dried by a very gentle heat. It is purified by making it into a paste with water, again squeezing it between the folds of blotting-paper, drying it, re-dissolving it in 5 times its weight of alcohol, decolorizing it with pure animal charcoal, distilling off greater part of the alcohol, and evaporation and crystallization by a very gentle heat; or only about ½ the spirit is distilled off, and 3 or 4 times its volume of water gradually agitated with it, the resulting milky liquid being then heated to boiling, and allowed to cool very slowly, when nearly the whole of the atropine crystallizes out after a few hours. The same may be effected by at once agitating 6 or 8 volumes of water with the alcoholic solution, and setting aside the mixture for 12 to 24 hours, by which time the crystallization will be completed. This process originated with Soubeïran, was improved by Mein, and subsequently,

with slight modifications, adopted by Liebig. The product is about 0·3 per cent. of the weight of the root operated on.

(4) The filtered tincture is precipitated with iodine dissolved in an aqueous solution of iodide of potassium; the resulting iodurett ed hydriodate of atropine is decomposed by zinc-and-water; the metallic oxide is separated by means of carbonate of potash; and the alkaloid thus obtained is dissolved in alcohol, and crystallized. (Bouchardat and Cooper.)

(5) The dry leaves of belladonna are gently boiled for two hours in distilled water just sufficient to cover them, and the resulting decoction is strained through a coarse cloth into a large precipitating jar; this process is repeated with a second quantity of distilled water, and the two decoctions are mixed; concentrated sulphuric acid is now added in the proportion of 2 dr. to every lb. of leaves operated on, by which the vegetable albumen of the decoction is precipitated, and the liquid becomes clear and sherry-coloured; the clear liquor is decanted or siphoned off, and if necessary filtered; the filtrate is decomposed by either passing a stream of gaseous ammonia through it, or by suspending in it a lump of carbonate of ammonia. The effect is that the liquid turns black, and crystals of atropine are slowly formed and deposited. At the expiration of a day or two, the supernatant mother-liquid is removed with a siphon, and the crystals are thrown on a filter to drain and dry. It may be purified by re-solution and crystallization. 1 lb. of leaves yields 40 gr., or at the rate of 0·57 per cent. (Luxton.)

(6) To 1 qt. of the crystallized juice of the plant (previously heated to coagulate its albumen, filtered, and allowed to cool) is added 1 dr. caustic potash and 1 oz. chloroform; the whole is then agitated well, and after ½ hour's repose, the supernatant liquor is poured from the discoloured chloroform, which, after being washed with distilled water as long as it gives any colour to it, is placed in a small retort, and the chloroform distilled off by a water-bath; the residue is dissolved in a little water acidulated with sulphuric acid, and precipitated by potash carbonate in slight excess; the precipitate is redissolved in alcohol, and the solution, by spontaneous evaporation, yields crystals of atropine. (Rabourdin.)

(7) The expressed juice of the fresh, or watery extract of the dry plant, is treated with caustic soda in slight excess, and agitated with 1½ times the volume of ether; the atropine taken up by the ether is re-deposited after repose for some time, and purified by repeating the treatment with fresh ether as often as necessary. (Ure.)

(8) Freshly precipitated hydrate of magnesia is added to the coagulated and filtered expressed juice, and the mixture evaporated to dryness as quickly as possible in a water-bath; the residue is pulverized and digested in strong alcohol, and the clear liquid allowed to evaporate spontaneously. The crystals may be purified by repeated re-solutions in alcohol.

(9) The following improved process is recommended by A. W. Gerrard, who notices several objections to preceding ones. Pack 1000 *grm.* of well powdered belladonna leaf or root in a percolator, and allow it to macerate 24 hours with 1000 *cc.* of 84 per cent. alcohol; now add in parts of 250 *cc.* at intervals of about 4 hours, another 1000 *cc.* of alcohol; when percolation ceases, displace with water, recover the alcohol by distillation, and treat the extract with 5 times its volume of water; carefully separate the resin and fatty matter, and wash it twice, mixing all the washings; evaporate them to 300 cc. and add a good excess of ammonia; expose in a shallow dish for some hours that excess of ammonia may volatilize; now shake well with an equal volume of ether, separate the ether, and withdraw the atropine from it by shaking with a small volume of water and repeated additions of acetic acid. Working in this way, the ether may be used continuously to extract the mother-

liquor until it is exhausted. The acetic solution of atropine is now shaken with and filtered through a little animal charcoal, concentrated to a small volume, treated again with ammonia, and dissolved out a second time with ether. Allowing the ether to spontaneously evaporate, the atropine will separate in exceedingly fine filamentous crystals of a satiny lustre and almost white. Two more crystallizations will render them quite white. In conducting this process, it is important to remove the whole of the alcohol from the tincture, also to employ ether free from alcohol. (*Pharm. Jl.* [3] xii. 346.)

Berberine.—Berberine exists in the root of the common barberry (*Berberis vulgaris*), in the calumba root of India (*Menispermum palmatum*), and in the calumba wood of Ceylon (*M. fenestratum*). It is prepared as follows :—

(1) A soft watery extract of the root or wood is digested in rectified spirit, with trituration, as long as anything is taken up; the resulting tincture, after repose, is filtered, and the alcohol is gradually distilled off until the residue has the consistence of a thin syrup. The crystals which form as the liquid cools are drained in a funnel, washed with a few drops of ice-cold water, pressed dry in bibulous paper, and then purified by solution and crystallization, first in rectified spirit, and then in distilled water.

(2) The root or wood, coarsely powdered, is digested in rectified spirit, and treated as in (1).

Brucine.—Brucine is contained in *Brucea antidysenterica*, St. Ignatius bean and *Strychnos Nux vomica* (along with strychnine). It is generally prepared from the latter plant, which is much cheaper. The powdered nuts are treated with very dilute, boiling sulphuric acid, and expressed. The acid is next saturated with excess of milk of lime, by which sulphates of lime, strychnine, and brucine are thrown down. The precipitate is collected on a filter, and dried, and then treated with boiling alcohol (·850 sp. gr.), which dissolves the two alkaloids. The liquid is filtered while hot, and in cooling deposits the greater part of the strychnine. The brucine remains in solution, and may be obtained by evaporation. They are both purified by repeated crystallization in alcohol.

Calumbine.—Calumbine is prepared from calumba root (*Menispermum palmatum*) by the following methods :—

(1) Digest the coarsely powdered root in water acidulated with acetic acid; express, filter, boil to $\frac{1}{2}$, again filter, add calcium carbonate in slight excess, and evaporate to dryness in a water-bath; powder the residue, and digest in boiling alcohol; it will deposit crystals of calumbine on cooling.

(2) Evaporate tincture of the root (made with rectified spirit) to dryness; dissolve residue in water, and agitate the solution with equal bulk of ether; after short repose, decant the ethereal portion, distil off most of the ether, and set the liquid aside to crystallize. (Wittstöck).

(3) The powdered root is covered with a 2 to 3 per cent. solution of oxalic acid for some hours, and the resulting extract is neutralized with ammonia, which takes up the calumbic acid, and leaves the calumbine pure. (Alessandri.)

Cascarilline. — Cascarilline may be prepared from the bark of *Croton Cascarilla* or *C. Eleutheria* by the following processes :—

(1) The bark is exhausted with cold water by percolation, precipitated with lead acetate, and the filtrate treated with sulphuretted hydrogen; the filtered liquid, after agitation with animal charcoal, and filtration, is gently evaporated to dryness. The powder is re-dissolved in boiling alcohol, and crystallized by very slow or spontaneous evaporation. (Duval.)

(2) A quantity of coarsely powdered cascarilla bark is covered with a 2 to 3 per cent. solution of oxalic acid and allowed to stand for 12 hours, the mixture being frequently shaken. At the expiration of this period, the temperature of the mixture is gradually raised to 140° F. (60° C.), after which it is allowed to

cool. Lastly, the liquid is filtered and the marc well pressed. The filtrate is then saturated with ammonia, and evaporated at a low temperature to $\frac{2}{3}$ of its bulk. The liquid is again allowed to cool, and a deposit separates, if any has been formed. The liquid is poured into a flask containing pure ether, the whole being shaken for some time. After being allowed to stand for 3 hours or more, the ethereal solution is poured off and distilled, so as to recover the greater part of the ether. The evaporation is completed spontaneously in a current of air, without the application of heat, the result being pure white cascarilline. The ethereal solution contains a small quantity of essential oil, nearly the whole of which passes over during the process of distillation; but this in no way prevents the ether from being used for the separation of another batch of the alkaloid.

Colchicine is obtained from the seeds of the meadow saffron (*Colchicum autumnale*) by the following process:—Macerate the bruised seeds in boiling alcohol, add magnesia to throw down the alkaloid, digest the precipitate in boiling alcohol, and filter. By cautious evaporation, colchicine will be deposited, and may be purified by re-solution and crystallization in alcohol.

Morphine is the most important alkaloid obtained from opium, itself a product of several species of poppy (*Papaver*). Cooley gives the following 4 methods of preparing morphine:—

(1) Turkey opium (cut into thin slices), 1 lb., is macerated for 24 hours in 1 qt. water, and the liquid portion is decanted; the residuum is macerated for 12 hours with a second quart of water, and the process is repeated with a third quart of water, after which the insoluble portion is subjected to strong pressure; the mixed liquids are evaporated by water or steam heat to a pint, and filtered through calico; to the filtrate is added a solution formed of 6 dr. calcium chloride, dissolved in 4 fl. oz. distilled water, and the liquid is further evaporated until it is so far concentrated that nearly the whole of it becomes solid on cooling; this is enveloped in a couple of folds of strong calico, and subjected to powerful pressure, the dark liquid which exudes being preserved for subsequent use; the squeezed cake is next treated with about $\frac{1}{2}$ pint of boiling water and the undissolved portion is washed on a paper filter; the filtered solution is again evaporated, and the solid portion thus obtained submitted to pressure as before; if the product is not quite white, this process is repeated a third time; the squeezed cake is now dissolved in 6 fl. oz. of boiling water, and the solution filtered through animal charcoal (if necessary); to the clear solution is added ammonia in slight excess; the crystalline precipitate, which forms as the liquid cools, is collected on a paper filter, washed with cold distilled water, and, lastly, the filter is transferred to a porous brick, in order that the morphine which it contains may become dry. (From the liquids reserved from the expressions, more morphine may be obtained by dilution with water, precipitation with ammonia, re-solution in boiling water, and treatment with a little animal charcoal, &c., as before.)

(2) Hydrochlorate of morphine, 1 oz., is dissolved in 1 pint distilled water, and 5 fl. dr. (or q. s.) ammonia previously diluted with 1 fl. oz. water is added, with agitation; the precipitate is well washed in distilled water, and dried by a gentle heat. By a similar process, morphine may be obtained from its other salts.

(3) A cold aqueous infusion of opium is precipitated with carbonate of sodium in excess; the precipitate is washed, first with cold water, and then with cold alcohol of ·85 sp. gr.; the residue is dissolved in weak acetic acid; the solution is filtered through animal charcoal, and precipitated with ammonia; the precipitate is again washed with cold water, dissolved in alcohol, and crystallized. A good process where spirit is cheap. (Merck.)

(4) Opium, 4 parts, is made into a strong infusion with water, q. s.; 1 part

lime, reduced to a state of milk with water, is then added; the mixture next heated to boiling, at once filtered through linen, and treated, whilst still hot, with chloride of ammonium, in fine powder, in slight excess (about 1 oz. to each lb. of opium); the morphine is deposited as the liquid cools, and may be purified by a second solution in lime and precipitation by chloride of ammonium. This process is remarkably simple, and in many points is preferable to any other, either on the small or large scale. (Mohr.)

(5) Pure.—The opium is digested in tepid water, and strongly expressed several times. The solution is evaporated down with powdered carbonate of lime. When about the consistence of a syrup, water is added, and the precipitated meconate of lime is filtered off. The liquid is again concentrated at a gentle heat. When concentrated and quite cold, a solution of chloride of calcium and a little hydrochloric acid are added, and the mixture is left to stand for 15 days. During this time crystals of hydrochlorates of morphine and codeine are deposited. In order to separate these, the crystals are dissolved in water, and treated with dilute ammonia, which precipitates the morphine, leaving the codeine in solution. The morphine is purified by repeated crystallizations in alcohol. When prepared in this way, morphine is often contaminated with a little narcotine, which may be removed by treating with ether, in which morphine is quite insoluble.

Narcotine is prepared from opium by the following methods:—(1) From opium exhausted of soluble matter by cold water, by treating it with water acidulated with acetic or hydrochloric acid, filtering, neutralizing with ammonia, and dissolving the washed precipitate in boiling alcohol; the narcotine is deposited as the liquid cools, and may be purified by solution in ether. (2) By acting with ether on opium previously exhausted by cold water. (Cooley.)

Nicotine is obtained from tobacco-leaves by the processes enumerated below:—

(1) Infuse tobacco-leaves for 24 hours in water acidulated with sulphuric acid, strain, evaporate to a syrup, add $\frac{1}{6}$ of its volume of a strong solution of potash, and distil in an oil-bath at 288° F. (142° C.), occasionally adding a little water to assist the process and prevent the too great concentration of the solution of potash in the retort; next saturate the distilled product with oxalic acid, evaporate to dryness, digest in boiling absolute alcohol, evaporate the resulting tincture to a syrup, and decompose the oxalate of nicotine thus obtained by adding potash to it in a close vessel, and agitate the mass with ether, repeating the process with more ether until all the nicotine is dissolved out; lastly, distil the mixed ethereal solution in an oil-bath. At first ether comes over, then water, and lastly nicotine, which, towards the end of the process, assumes a yellowish tint. (Ortigosa.)

(2) This chiefly differs from the preceding by the concluding distillation being conducted in a retort, by the heat of an oil-bath, at the temperature of 284° F. (140° C.), in a current of hydrogen, for 12 hours; after which, by raising the heat to 356° F. (180° C.), the nicotine distils over pure, drop by drop. (Schlösing.)

(3) A tin vessel provided with 2 tubulures is filled with tobacco, which is previously damped with sodium carbonate. One of the tubulures admits a glass tube reaching nearly to the bottom of the vessel; the other is provided with a glass tube merely penetrating the cork. The vessel is made air-tight, placed in a boiling-hot steam bath, and a rapid stream of carbonic acid gas is passed through it, entering the vessel by the longer and leaving it by the shorter tube; the latter dips into a mixture of alcohol and dilute sulphuric acid. In this manner, a large yield of perfectly colourless nicotine is obtained. In order to obtain the pure alkaloid, caustic baryta is added to the solution, the latter is evaporated to dryness, and

the pure nicotine is extracted with ether. (Kirschmann.)

Piperine is obtained from black pepper (*Piper nigrum*) as follows. The alcoholic extract is treated with a weak solution of caustic potash (1 to 100), and the residue, after being washed with cold water, is dissolved in alcohol; the solution is next agitated with a little animal charcoal, and the filtrate is allowed to evaporate spontaneously; the product may be purified by re-solution in alcohol and re-crystallization. (Cooley.)

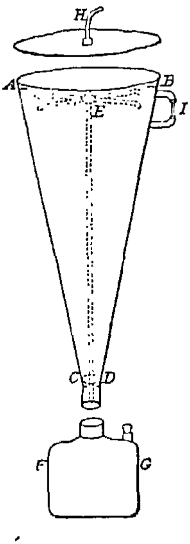
Quinine, &c.—Of the alkaloids present in cinchona barks, the four possessing remedial value are, stated in order of merit, quinidine, quinine, cinchonidine, and cinchonine. Their relative and total proportions are each subject to great variations, in fact no two samples of the bark are alike. Until recently, quinine was the only member of the group admitted into use; but experiment has shown that cinchonidine and cinchonine are very little inferior to the former as a febrifuge, and it is probable that they will not be thrown away in future. Quinidine is in too small proportion to deserve special notice. Though it is impracticable to state the percentage of alkaloids, individually or collectively, in each species of bark, the latter are nevertheless distinguished by well-marked characteristics, a knowledge of which is essential for their most economical and suitable employment. Pale or crown bark is rich in crystallizable quinine, and is highly valued by the manufacturers of quinine sulphate in this country. Yellow bark is even more highly esteemed for this purpose. Red bark, on the other hand, while as rich as either of the others in total alkaloids, contains only little quinine, and that difficult of extraction. Moreover, this species is hardier, grows better, and yields about ⅓ more bark than *officinalis*, so that as a source of total alkaloids it is more deserving of attention than the other two, though inferior to them if they could be got to grow as luxuriantly. The red bark, too, is the most valuable for the preparation of tonic decoctions, tinctures, &c., largely used in Europe; and in consequence of this fact, its price in Western markets is but little, if at all, inferior to that of the kinds richer in quinine. The barks best adapted for quinine-making fetch the best prices in European markets, and will probably continue to do so. Red bark will doubtless recede in price when production increases, as the demand for that kind is limited in Europe; it is, however, the only kind likely to be used in the East for the local manufacture of a febrifuge, as efficient as, while much cheaper than, sulphate of quinine. Two conditions bearing upon this part of the subject are:—(1) That high temperature increases the cinchonidine at the expense of the quinine, so that barks grown at a low elevation (or even at a high elevation, if exposed to sunlight), will be richer in the former and poorer in the latter, while a low mean temperature, within certain limits, favours the production of quinine; (2) That deprivation of light, without impeding the access of air and sun-heat, materially increases the proportion of total alkaloids.

The manufacture of a cheap febrifuge has engaged the serious attention of the Indian government, resulting in two such products—Broughton's "amorphous quinine," and the febrifuge called "quinetum" by Dr. de Vrij.

The former is prepared in the following way:—Strips of the bark are placed in a copper pan with sulphuric acid (1½ per cent. for trunk-bark, 1 per cent. or less for prunings, &c.), and a quantity of water from the fourth extraction (*v. post*); the whole is boiled for 1 hour, then subjected to a strong screw press, the liquid being caught in a wooden vat. The bark is reboiled with liquor from a third extraction, with an additional ½ per cent. of acid, for 1 hour, and is again squeezed. A third boiling is given in liquor from a fourth extraction, and, after squeezing, the bark is finally boiled with fresh water, sun-dried, and used as fuel. The resulting concentrated decoction is evaporated to

$\frac{1}{5}$, and cooled; it is then decomposed by addition of milk of lime in slight excess, which precipitates the alkaloids, with formation of insoluble lime salts; after standing for a day, the precipitate is filtered off, squeezed, dried, and powdered. The powder is then placed in the apparatus shown in Fig. 5.; A B C D is a sheet-iron cone, traversed by an upright tube E, terminating above in 4 open arms, and supported below on a flat iron disc C D. A copper vessel F G fits closely to the lower end of the cone. The latter is suspended, and connected, through the tube H, with a simple worm tub. The cone is packed with the precipitate up to E, the lid is put on, and alcohol is added slowly from above, till F G is about $\frac{1}{3}$ full of the saturated spirit, which is then carefully neutralized by dilute sulphuric acid. The cone is then connected with the condenser through H, and a fire is lighted below. The spirit boiling in F G rises in vapour through E, passes out at the openings, and condenses so as to form a liquid stratum above the precipitate. This is observed by the gauge B I; uncondensed vapour passes through H, and is caught. A small quantity of spirit, by constant circulation, extracts all the alkaloids without waste. The alkaloid in F G is neutralized with dilute acid every two days. When the precipitate no longer contains any alkaloid, F G is removed, and the alcohol is distilled off; the alkaloid is washed with water, while the alcohol is recovered with a maximum loss of 6 per cent. The alkaloid is treated suddenly with about 10 times its bulk of cold water, which separates the black resin present; the addition of a little dilute acidulated solution of sodic sulphide will remove any copper accidentally present. The alkaloid solution being still coloured, a small quantity is precipitated by dilute caustic soda, the colouring matters falling at the same time. The whole is then filtered through cloth; and the alkaloid is precipitated by caustic soda, filtered, pressed, dried, and powdered. Potash may replace soda, if more easily or cheaply procurable. This process was employed to produce 600 lb. of alkaloid in the Nilgiris; but the product was found to cost more than ordinary commercial quinine, assuming the value of dry trunk-bark at 2*s.* a lb., and branch-bark at 6*d.* The yield of alkaloid is, however, naturally much greater.

FIG. 5.



The second method, adopted by Wood, in Sikkim, is much simpler:—The dry bark is crushed into small pieces—not powdered—and is put into casks, where it is macerated in the cold with very dilute hydrochloric acid; the liquor is then run off into wooden vessels, and mixed with an excess of strong solution caustic soda; the precipitate formed is collected on calico filters, and well washed with water. The precipitate is then gently dried, and powdered, constituting the crude febrifuge, which requires purifying. This is performed by dissolving the product in dilute sulphuric acid, and adding a small quantity of a solution of sulphur in caustic soda. After 24 hours, the liquor is carefully filtered; the filtrate is mixed with caustic soda, and the resulting precipitate is collected on calico, washed with a little water, dried, and powdered; it is then ready for use.

The operation is conducted in casks, worked in sets of three. Each cask receives 1 *maund* (82 lb.) of dry bark, which will undergo four successive macerations of half a week's duration, the liquor being passed through the three casks in rotation. The liquor used for the 4th (last) maceration is acidulated water; when drawn off, it forms the liquor for the 3rd cask; thence it is conducted to the 2nd cask; and finally to the 1st cask, containing new bark, whence it is run off for precipitation. When starting anew, each cask will contain dry bark, so that the system of rotation is not brought into full operation till after the first fortnight. The liquor for precipitation is run into tubs; the others are drawn into buckets, for transference to the respective casks. Acidulated water is made in a vat, by adding 1 gal. hydrochloric acid to 100 gal. water. The weight of acid used in the exhaustion is 6¼ per cent. of the weight of dry bark. The caustic soda solution consists of 1 part of the alkali dissolved in 3 parts of water; it is stored in iron vessels. The quantity required for precipitation of the bark liquor is judged of by the curdy appearance assumed by the precipitate; every 100 lb. of dry bark consumes about 6½ lb. of the alkali.

Filtration of the precipitate is commenced on the following day, when the liquor is transferred to the calico strainers, previously wetted. The first portions that run through are returned, until the passing liquor has a bright ruby colour; it is then allowed to flow away by a drain. When all the liquor has drained off, water is passed through the precipitate, until it ceases to acquire a red tint. The alkaloids on the filter should then exhibit a uniform cream-colour. The precipitate is dried, reduced to fine powder, and stored in suitable bins.

During the drying of the precipitate, a slight reddish-brown colour is developed; this is removed by the following process of purification:—14 gal. of water are mixed with 2 pints of sulphuric acid, and 20 lb. of the dry powder; about ½ pint of solution of sulphur in caustic soda is stirred in, and the whole is left for 24 hours. It is then filtered through calico into a clean vessel, care being taken to get the liquor perfectly bright; about 6 gal. of water are used to wash the sediment left on the filters; the clear filtrate is thoroughly mixed with soda solution, to precipitate the alkaloids; the precipitate is collected on calico, washed with a small quantity of water, drained, dried, and reduced to fine powder. Wooden vessels are not so suitable for this operation as are those of enamelled iron, or earthenware.

The bark used is exclusively dry *succirubra*, and care is taken to mix the root-, stem-, and branch-barks together, as nearly as possible in the proportions in which they are yielded by the plantations. Green bark would not be available at all seasons; and it has been found that the trifling cost of drying the bark is more than repaid by the better product.

The purified febrifuge is a fine white powder, which, however, acquires a slight buff tint by keeping. It never agglutinates, and is freely soluble in weak acids, such as lemon-juice, &c. The cost price of this febrifuge is estimated at 1*s.* 9*d.* an oz.; it is as efficient as quinine at 9*s.* an oz.

Quinine.—The bark is powdered, and boiled several times with sulphuric, or hydrochloric acid; after each boiling it is carefully expressed, and afterwards the liquors are mixed together. The quinine, cinchonine, and some impurities are precipitated with carbonate of soda, and the precipitate is collected in a cloth, compressed, dried, and digested with alcohol. The solution is next treated with dilute sulphuric acid, in sufficient quantity to exactly saturate the alkaloids, after which the alcohol is removed by boiling. The liquid is now allowed to cool, when the quinine is deposited as sulphate in crystals. The cinchonine, which is more soluble, remains in the mother-liquors. The crystals of sulphate of quinine are dissolved in alcohol, and the solution is decolorized by the addition of a little animal black; they are subsequently purified by recrystallization. If the mother-liquors still contain quinine, they are precipitated by carbonate of soda, and the precipitate is re-dissolved in sulphuric acid. The sulphate of quinine is separated by repeated crystallizations. Pure quinine may be prepared from the sulphate by precipitating it with a mineral alkali. (Spons' 'Encyclopædia.')

Salicine is found in the bark and leaves of several species of *Salix* and *Populus*, but most abundantly in the white willow (*S. alba*) and aspen (*P. tremula*). It is prepared as follows:—

(1) Exhaust willow bark by repeated coction with water, concentrate the mixed liquors, and, while boiling, add litharge until the liquid is nearly decolorized; filter, remove the dissolved oxide of lead, first by sulphuric acid, and afterwards by sulphuret of barium; filter, and evaporate, that crystals may form; the crystals must be purified by re-solution and re-crystallization. (Merck.)

(2) As No. 1, but using a stream of sulphuretted hydrogen to free the solution from lead.

(3) To a strong filtered decoction of willow bark add milk of lime, to throw down the colour; filter, evaporate the liquor to a syrupy consistence, add alcohol (sp. gr. ·847), to separate the gummy matter, filter, distil off the spirit, evaporate the residue, and set it aside in a cool place to crystallize; the crystals are purified by solution in boiling water, agitation with a little animal charcoal, and re-crystallization.

Strychnine may be obtained from nux vomica (*Strychnos nux vomica*) and from the Ignatius bean (*S. Ignatii*) by the following methods:—

(1) Dissolve hydrochlorate or sulphate of strychnine in distilled water, and throw down the alkaloid with ammonia, carefully avoiding excess; redissolve the precipitate in hot rectified spirit, and collect the crystals which form as the liquid cools.

(2) Nux vomica (in powder), 1 lb., is digested for 24 hours in ½ gal. of water acidulated with 2 fl. dr. of sulphuric acid, after which it is boiled for ½ hour, and the decoction decanted; the residue is boiled a second and a third time with a fresh ½ gal. of water acidulated with 1 fl. dr. of the acid, and the undissolved matter is finally submitted to strong expression; the decoctions are next filtered and concentrated to the consistence of a syrup, which is boiled with 3 pints rectified spirit for about 20 minutes, hydrate of calcium (1 oz., or q. s.) being added in successive portions during the ebullition, until the solution becomes distinctly alkaline; the liquid is then filtered, the spirit distilled off, and the residue dissolved in diluted sulphuric acid, q. s.; ammonia, in slight excess, is added to the filtered solution, and the precipitate which falls is collected upon a paper filter, and dried; it is next re-dissolved in a minimum of boiling rectified spirit, and digested with ½ oz. of animal charcoal for 20 minutes; the filtered liquid, as it cools, deposits strychnine in crystals.

(3) Nux vomica, 1 lb.; acetate of lead, 180 gr.; solution of ammonia, q. s. Subject the nux vomica for 2 hours to steam in any convenient vessel; chop or slice it; dry it in a water-bath or hot-air chamber, and immediately grind it in a coffee-mill. Digest the powder at a gentle heat for 12 hours with 2 pints of the spirit and 1 pint of the water, strain through linen, express strongly, and repeat the process twice. Distil off the spirit from the mixed fluid, evaporate the watery residue to about 16 oz., and filter when cold. Add now the acetate of lead, previously dissolved in distilled water, so long as it contains any precipitate; filter; wash the precipitate with 10 oz. of cold water, adding the washings to the filtrate: evaporate the clear fluid to 8 oz., and, when it has cooled, add the ammonia in slight excess, stirring thoroughly. Let the mixture stand at the ordinary temperature for 12 hours; collect the precipitate on a filter, wash it once with a few oz. of cold distilled water, dry it in a water-bath or hot-air chamber, and boil it with successive portions of rectified spirit, till the fluid scarcely tastes bitter. Distil off most of the spirit, evaporate the residue to the bulk of about ½ oz., and set it aside to cool. Cautiously pour off the yellowish mother-liquor (which contains the brucine of the seeds) from the white crust of strychnine which adheres to the vessel. Throw the crust on a paper filter, wash it with a mixture of 2 parts of rectified

spirit and 1 of water, till the washings cease to become red on the addition of nitric acid; finally dissolve by boiling it with 1 oz. of rectified spirit, and set it aside to crystallize. More crystal may be obtained by evaporating the mother-liquor.

Veratrine is easily exhausted from the seeds of *Veratrum Sabadilla*, by the following process.

The crushed seeds are exhausted with a 2 to 3 per cent. solution of oxalic acid for 24 hours, when a clear liquid is afforded, and is neutralized by ammonia. After about ½ hour, a precipitate is formed in the liquid; this is separated by filtration and dissolved in pure cold alcohol. The alcoholic tincture, on evaporation, yields veratrine that is sufficiently white and crystalline. It is obtained perfectly so by dissolving in ether, without using any decolorizing material. (Alessandri.)

BAKING - POWDERS. — The real value of baking-powders lies in their leavening power, or available gas. Dr. E. G. Love made an interesting examination of the brands sold in the United States, to test their comparative worth, calculating from the ordinary price of 50 cents (2s. 1*d.*) per lb., with the following results.

Name.	Cub. in. of gas per oz. of powder.	Worth per lb.
Royal (cream tartar)	127·4	50
Patapsco (alum)	125·2	49
Rumford's (phosphate) fresh	122·5	48
Rumford's (phosphate) old	32·7	13
Hanford's none-such	121·6	47¾
Redhead's	117·0	46
Charm (alum)	116·9	46
Amazon (alum)	111·9	44
Cleveland's	110·8	43
Czar	106·8	42
Price's cream	102·6	40
Lewis's condensed	98·2	38½
Andrew's pearl	93·2	36¾
Hecker's perfect	92·5	36
Bulk powder	80·5	30
Bulk aerated powder	75·0	29

Dr. Love regards all alum powders as very unwholesome, while the phosphate and tartaric acid powders liberate their gases too freely in process of baking, or suffer deterioration under varying climatic conditions. Dr. H. A. Mott also examined no less than 42 samples of baking-powder. In the majority he found large quantities of alum, which he considers highly injurious, and in this opinion is supported by most medical men. He recommended the U.S. government to provide cream of tartar baking-powders for the Indians.

Following are recipes for compounding baking-powders:—

(1)	Tartaric acid powder	8 oz.
	Bicarbonate soda	9 ,,
	Rice flour	10 ,,

A teaspoonful to every 1 lb. flour.

(2)	Bicarbonate soda	1 lb.
	Farina	1 ,,
	Powdered alum	¾ ,,
	Carbonate magnesia	½ oz.

Dry in oven separately. Magnesia may be put on the flour. Tartaric acid may replace the alum.

(3)	Bicarbonate soda	16 oz.
	Tartaric acid	14 ,,
	Carbonate magnesia	6 ,,
	Farina	12 ,,

Rub through a sieve.

(4)	Bicarbonate soda	16 oz.
	Dry tartaric acid	8 ,,
	Rice flour	12 ,,

(5)	Dry carbonate soda	8 oz.
	Dry tartaric acid	6 ,,
	Carbonate magnesia	2 ,,
	Turmeric powder	1 ,,

The soda and acid are properly dried before mixing, or the powder spoils by keeping. Preserve in stoppered bottles.

(6) Sal aeratus appears to be applied indiscriminately to sodium bicarbonate, potassium bicarbonate, and ammonium carbonate.

(7) American. For making light pastry. Tartaric acid and chalk.

(8) Borwick's German is an artificial fermentation powder, compounded with coarse maize flour.

(9) Goodall's is a compound of:—

Rice flour	2 parts.
A mixture of tartaric acid and bicarbonate of soda (each)	1 part.

(10) Horsford's. This is a powder supplied in two packets. The one contains an acid phosphate of lime and magnesia, made up with a certain quantity of flour, and the other is bicarbonate of soda, with a little chloride of potassium.

(11) Tartaric acid ½ lb.; bicarbonate of soda and potato farina or British arrowroot (of each in powder) ¾ lb. Separately dry them perfectly by a very gentle heat, then mix in a dry room, pass the mixture through a sieve, and at once put it into packets, observing to press it hard, and to cover it with tinfoil or close-made paper, to preserve it as much as possible from the air and moisture.

(12) Delforte's.

Powdered tartaric acid	¼ lb.
Powdered alum	
Bicarbonate soda	¾ ,,
Farina	1 ,,

Dry separately, as before, mix, and further add sesquicarbonate of ammonia (in powder), 3 oz. Lastly, closely pack it in tinfoil.

(13) Green's.

Tartaric acid	35 lb.
Sesquicarbonate of soda	56 ,,
Potato flour	1 cwt.

Mix as before.

For use, 1 or 2 teaspoonfuls of baking-powder are mixed with the dry flour and other ingredients, which are then made into a dough, as quickly as possible, with cold water, and at once baked or boiled. By the addition of about ½ dr. of turmeric powder to each 1 lb. of the mixture it is converted into egg-powder. It should be preserved in bottles or tins, so as to prevent the absorption of moisture.

(14)

Tartaric acid	½ lb.
Bicarbonate of soda	12 oz.
Starch	12 ,,

Dry each thoroughly previous to admixture, which is effected by passing through a fine sieve repeatedly; pack the powder down tightly, to prevent the absorption of moisture.

(15) Recipe No. 4 would cost, if the articles were obtained by the hundredweight, about 4d. per lb., or ¼d. per packet. The packets are made on a block of the proper size, first rolling the paper on, then pasting down the side, and lastly the bottom, doubled neatly up. Then a box must be provided, holding half-gross packets, show-bills, &c. A half-gross box of penny packets will fetch (in London) about 3*s*.

(16)

Bicarbonate of soda	4 oz.
Tartaric acid	3 oz.
Farina	16 oz.

Mix all together. By farina is meant any cheap farinaceous material — wheat, rice, or sago flours, &c. To make the packets requires a piece of wood, say 6 in. long, for small packets, and the exact size in thickness and width that the packet is to be. The end of this piece should fit into a block of wood and go through it. Take the paper and fold it on the end of the stick, and close it at the end so as to make a square bag; now put the stick with the paper on it into the block, and withdraw the stick, leaving the paper in the block. It is more convenient to measure the powder than to weigh it. Put the powder in a small tin-plate funnel, and shake it into the paper; remove the funnel, and fold down the other end of the paper, flatten the folds with the end of the square stick and push the packet out of the block. The whole operation of making the packet should take a very short time.

(17) Ammonia has recently been selected as a superior agent in baking powders, being extremely volatile, and leaving no residue in the bread. It would seem to be most suitably employed as an acid phosphate of ammonia in conjunction with carbonate or bicarbonate of potash or of soda.

BITTERS.—The term "bitters" is applied in the liquor trade to a class of compounds prepared by steeping vegetable bitters in weak spirit for some days, with the addition of aromatic flavourings, syrup, and colouring matter. The following are the chief kinds :—

Amazon.—90 gal. plain proof spirit; 3¼ lb. red Peruvian bark; 3¼ lb. calisaya bark; 1⅙ lb. calamus root; 4¾ lb. orange peel; 3½ oz. cinnamon; 3½ oz. cloves; 3½ oz. nutmeg; 2 oz. cassia buds; 6½ lb. red sanders wood. First mash all the ingredients, put them in the spirit, and let them infuse 14 days, stirring the mixture well twice every day. Rack off and colour with 11 pints brandy colouring, to get a dark red tint. Stir ¼ hour. Dissolve 30 lb. white sugar in 30 gal. water; add, and again stir ½ hour. Let the mixture rest 4 or 5 days, and when bright, bottle. If the sanders wood is not used the colour will be a bright amber. Compounded according to the above directions, will yield 120 gal. 25° below proof.

Angostura.—4 oz. gentian root; 10 oz. each calisaya bark, Canada snake-root, Virginia snake-root, liquorice root, yellow bark, allspice, dandelion root, and Angostura bark; 6 oz. cardamom seeds; 4 oz. each balsam of tolu, orangetis, Turkey rhubarb, and galanga; 1 lb. orange peel; 1 lb. alkanet root; 1½ oz. caraway seed; 1½ oz. cinnamon; ½ oz. cloves; 2 oz. each nutmegs, coriander seed, catechu and wormwood; 1 oz. mace; 1¼ lb. red sanders wood, and 8 oz. turmeric. Pound these ingredients and steep them for 15 days in 50 gal. proof spirit; before filtering, add 30 lb. honey.

Aromatic.—Macerate 2¾ lb. ground dried small orange apples, ¼ lb. ground dried orange peel, 2 oz. ground dried calamus root; 2 oz. ground dried pimpinella root; 1 oz. ground dried cut hops, for 14 days, with 10 gal. of spirit at 45 per cent.; press, and add 2½ pints brown sugar syrup. Filter. Colour dark brown.

Boker's.—1½ oz. quassia; 1½ oz. calamus; 1½ oz. catechu (powdered); 1 oz. cardamom; 2 oz. dried orange peel. Macerate for 10 days in ½ gal. strong whiskey, and then filter and add 2 gal. water. Colour with mallow or malva flowers.

Brandy.—Grind to coarse powder 3 lb. gentian root, 2 lb. dry orange peel, 1 lb. cardamom seeds, 2 oz. cinnamon, 2 oz. cochineal. Infuse 10 days in 1 gal. brandy, 8 gal. water, and filter.

Essence.—40 gal. proof spirit; 1 dr. oil of anise; 1 dr. oil of caraway; ½ dr. oil of cloves; 1 dr. oil of lemon; 1 dr. oil of oranges; 1 dr. oil of cinnamon; ½ dr. oil of bitter almond; 1 gal. sugar syrup. Cut the oils in 95 per cent. alcohol, and mix. Colour with brandy colouring.

French Cognac.—1½ lb. each red Peruvian bark, calisaya bark, bitter orange peel, and sweet orange peel; 2 oz. calamus root; 4 oz. cardamom seeds; 1½ oz. each cinnamon, cloves, and nutmegs; 4 oz. caraway seed; and 3 lb. wild cherry bark. Pound all these ingredients to a coarse powder, and steep for 15 days in 45 gal. proof spirit (or 60 gal. spirit 25° below proof), stirring occasionally. Then rack it off, and mix sufficient caramel to make it a dark red; add 15 lb. white sugar dissolved in 15 gal. water; let the whole settle, then filter. If the bitters are required to be of an amber colour, omit the wild cherry bark and the caramel colouring.

Hamburg.—Grind to a coarse powder 2 oz. agaric, 5 oz. cinnamon, 4 oz. cassia buds, ½ oz. grains of Paradise, 3 oz. quassia wood, ¾ oz. cardamom seeds, 3 oz. gentian root, 3 oz. orange apples dried, 1½ oz. orange peel. Macerate with 4¾ gal. 95 per cent. alcohol, mixed with 5¾ gal. water; add 2¾ oz. acetic ether. Colour brown.

Nonpareil.—Grind to coarse powder 2 oz. Peruvian bark, ½ oz. sweet orange peel, ½ oz. bitter orange peel, 25 gr. cinnamon, 25 gr. cloves, 25 gr. nutmeg, 15 cayenne seeds. Infuse 10 days in 2 gal. 65 per cent. alcohol, then filter.

Orange.—(1) Macerate 6 lb. orange peel for 24 hours with 1 gal. water, cut the yellow part of the peel from off the white, and chop it fine; macerate with 4¾ gal. 95 per cent. alcohol for 2 weeks, or displace; then add a syrup made of

4¼ gal. water and 16 lb. sugar. Filter through Canton flannel.

(2) ½ oz. Seville orange peel; ¼ oz. lemon peel; ¼ oz. gentian root; ¼ oz. ginger, all bruised and put into a jug; pour a pint of boiling water on it, and cover up with a cloth; let it stand ½ hour, strain, and add 2 tablespoonfuls of brandy as preservative.

Peruvian.—8 oz. red Peruvian bark; 8 oz. orange peel; 1½ dr. each cinnamon, cloves, and nutmeg; and 75 cayenne pepper seeds. Infuse them, well bruised, in 8 gal. proof spirit, for 15 to 20 days, stirring every day. Draw off and filter.

Spanish.—Grind to coarse powder 5 oz. polypody, 6 oz. calamus root, 8 oz. orris root, 2½ oz. coriander seed, 1 oz. centaurium, 3 oz. orange peel, 2 oz. German chamomile flowers; then macerate with 4¾ gal. 95 per cent. alcohol, and add 5¼ gal. water and 1½ oz. sugar. Filter, and colour brown.

Stomach.—Grind to a coarse powder ½ lb. cardamom seeds, ⅛ lb. nutmegs, ¼ lb. grains of Paradise, ½ lb. cinnamon, ¼ lb. cloves, ¼ lb. ginger, ¼ lb. galanga, ¼ lb. orange peel; ⅛ lb. lemon peel; then macerate with 4¾ gal. 95 per cent. alcohol, and add a syrup made of 4½ gal. water and 12 lb. sugar; filter.

Stoughton.—(1) To 12 lb. dry orange peel, 3 lb. Virginia snake-root, 1 lb. American saffron, 16 lb. gentian root, add 1 lb. red sanders wood. Grind all the ingredients to a coarse powder, and macerate for 10 days in 20 gal. 65 per cent. alcohol, then filter.

(2) 2 lb. ginseng; 2 lb. gentian root; 1½ lb. dry orange peel; ½ lb. Virginia snake-root; 1 oz. quassia; ¼ lb. cloves, 3 oz. red sanders wood; 3 gal. alcohol 95 per cent.; 3 gal. soft water. Grind all the ingredients to coarse powder, infuse 10 days, and filter.

Wild Cherry.—Wild cherry bark, 4 lb.; squaw vine (Partridge berry), 1 lb.; juniper berries, 8 oz. Pour boiling water over, and let stand for 24 hours; strain, and again pour boiling water on the ingredients; let macerate for 12 hours, then express and filter through paper, so that the whole will make 5 gal., to which add 3½ lb. of sugar, 1½ gal. molasses, 6 oz. tincture of peach kernels, 3 oz. tincture of prickly ash berries, 2 qt. alcohol.

BLEACHING.—Bleaching is the art of whitening or decolorizing substances. It may be conveniently divided into the following heads:—

Albumen.—Leon Maret is the inventor of a curious process of bleaching blood-albumen by the electric light. By a long exposure to this, the colouring matter of the albumen is said to be destroyed gradually, until a product is obtained which is almost as white as egg-albumen. The usual process for obtaining blood-albumen is followed, and when the albumen is separated from the blood, it is exposed to the electric light, either while still in the liquid state or when dried. By means of lenses, or reflectors, the light is projected from the lamps on the albumen. If the latter is in the liquid state, the exposure to the light is done in the drying stoves, where the albumen is placed in shallow trays, the light being projected on the surface. These trays are made of glass, in order to allow the rays to penetrate into the interior; 24 hours' exposure is said to produce complete decolorization. (See also p. 8.)

Animal Fibres. — (1) Animal fibres which have to be bleached with peroxide of hydrogen must first be subjected to a treatment which renders them fit to be perfectly soaked with the solution. All fat, suet, and uncleanliness must be taken off. The best methods of doing this are soap baths and 3 to 5 per cent. carbonate of ammonia solutions, and in some cases other solvents, such as sulphide of carbon, benzine, ether, &c. For bleaching, the solution of peroxide of hydrogen, which is 3 per cent. by weight, or 10 per cent. by volume, is neutralized by means of a few drops of ammonia, and then used as a bleaching bath. If the bleaching has to be continuous, it is recommended to use several baths of different strengths, in which the goods are passed, beginning from the weaker bath. The light has to be kept off, and the temperature must not rise above 77° F. (25° C.). Another method is to dip the cleaned goods in the solution of peroxide of hydrogen, in which they are left until soaked, and are then exposed to dry in a draught, the temperature not to rise above 68° F. (20° C.) The bleaching takes place energetically by the evaporation of the water and subsequent concentration of the peroxide.

(2) The use of bisulphite of soda has proved to be superior to the old method of bleaching in sulphur ovens. The process with the bisulphite requires 6 to 8 hours, and therefore the sulphur bleachers have been slow to adopt it, the sulphur method occupying less time. The following suggestions are made:— Prepare an ordinary dilute solution of soda bisulphite, with the necessary quantity of sulphuric acid, and use the following apparatus, which is on the same principle as that used in the cotton bleaching process in the Barlow kiers. A large cask, with sufficient strength to withstand some steam pressure, is previously filled with thoroughly moistened fibre and tightly pressed in. The prepared solution of soda bisulphite and sulphuric acid, not marking more than 7° Tw. is allowed to enter and soak through the whole lot of fibre; after 5 or 10 minutes' contact, steam is turned on, which presses the solution through the perforated pipe in the centre of the cask and out of the apparatus. The fibre is taken out and aired, by which the bleaching process will not be interrupted; and when nearly dry it is entered a second time. Probably 3 or 4 manipulations would suffice to finish the bleaching, and would not occupy more than 2 hours. The waste liquor is collected, and made up to the first strength for re-use. ('Textile Colourist.')

Coral.—First well wash in very dilute hydrochloric acid (1 part B.P. acid to 30 water); then well rinse in water, then put into some chloride of lime and water.

Cotton.—The bleaching of cotton goods has become a very large industry, and the processes involved are too numerous and complicated to admit of lucid description here. The reader should refer to the complete article on the subject in Spon's 'Encyclopædia,' pp. 471–508.

Esparto.—Esparto pulp for paper-making is bleached in the "poacher" by means of a solution of bleaching powder. Some manufacturers hasten the process by adding a little hydrochloric or sulphuric acid; others steam-heat the mass to about 90° F. (32° C.); others put in a small quantity of soda bicarbonate. The quantity of bleaching-powder necessary depends on the quality of the grass and the degree of boiling: 12 lb. per cwt. of esparto is a fair average. After being about 2 hours in the poacher, the almost white pulp is drained in large chests for 8 hours or longer, exposed to the action of light, and finally pressed to remove the excess of liquor.

Feathers.—(1) The feathers are put into a bath of permanganate of potash, containing 4 to 5 parts permanganate to 1000 of water; a solution of sulphate of magnesia of the same strength is added, and it is heated 140° F. (60° C.) at the most. The feathers, previously washed, are put into this bath, then taken out, rinsed, and passed through weak sulphuric acid at about 1½° to 3° Tw. (2) It is also possible to bleach the feathers in a bath of 1 part barium peroxide in 100 of water at 86° F. (30° C.). Leave 48 hours in this solution, wash, pass through weak acid bath, and wash. (3) Feathers may be bleached by exposure to the vapour of burning sulphur (sulphurous acid) in a moist atmosphere, but it is usually necessary to remove the oily matters from them before they can be satisfactorily so bleached. This may be accomplished by immersing them for a short time in good naphtha or benzine, rinsing in a second vessel of the same, and thoroughly drying by exposure to the air. This treatment does not injure the feathers. (4) Peroxide of hydrogen is largely employed. The advantage it offers is the oxidation and complete disappearance of the colour, without spoiling the structure of the feather. The feathers are first dipped in a solution of 1 to 2 per cent. carbonate of ammonia in water, in which they are slightly agitated, and left for about 12 hours at 68° F. (20° C.). The feathers are then taken through a tepid white soap bath, and well washed in water which is free of lime. The treatment with benzine and ether also gives good results. The bleaching bath is neutralized. Wood or metal vessels are not recommended for the baths, and it is better to use earthenware vessels. When bleached, the feathers are dried slowly at a low temperature in a draught, and are often beaten. A good result is obtained by dipping the bleached feathers in alcohol, which gives them a finer appearance. The succeeding operations are the same as by other processes. This method of bleaching feathers is said to prove superior to all others. Black spots are perfectly bleached after being exposed for some time. (5) The feathers are placed for 3 to 4 hours in a tepid dilute solution of bichromate of potash, to which some nitric acid has been cautiously added. After this lapse of time, the feathers will have assumed a greenish hue, owing to the chromium oxide precipitated; to remove this, they are placed in a dilute solution of sulphurous acid in water, when they become perfectly white. Care must be taken that the bichromate bath is not too strong, and especially that excess of nitric acid be avoided. (6) The objection attending the use of acid or alkaline baths is that they alter the texture of certain feathers. In Roy's process, the feathers are first soaped, and, after thorough washing, subjected to the action of ozone. By a succession of immersions in water and treatments with the gas, bleaching is effected without injury to the feathers. (7) Viol et Duplot's method rests on the fact that feathers immersed in resinous essences (e.g. turpentines, oils of lavender, thyme, &c.) or bituminous hydrocarbons, are bleached under the influence of light or heat. The feathers are kept in the vessels a longer or shorter time, according to degree of whiteness desired (generally about 3 or 4 weeks), at a temperature of 86° F. (30° C.), and exposed to the light. (8) The common method is as follows. The feathers are first washed in soap lather, well rubbed with the hands, and passed through clean scalding water. For white feathers, they are first exposed to the action of sun and dew for about a fortnight, washed in a hot bath containing Spanish white (the softest and purest white chalk), and passed through 3 clean waters; next they are blued by a rapid passage through a cold bath containing indigo; after this, they are sulphured by suspension in a sulphuring stove; and are finally hung upon cords to dry, being occasionally shaken to open the fibres. (9) Naturalists clean stuffed bird-skins by covering them over with common starch made with cold water into a thin paste. Let this dry for a couple of days, then "fillip" it off gently, beginning at the bird's head and going on regularly down to the tail, which will leave the feathers beautifully "plumed."

Guttapercha.—Dissolve in 20 times its weight of boiling benzol, add $\frac{1}{10}$ part plaster of very good quality, and agitate occasionally. By reposing for 2 days, the plaster is deposited and carries with it all the impurities not soluble in benzol. The clear decanted liquid is introduced by small portions into twice its volume of 90 per cent. alcohol, agitating continually. During this operation the guttapercha is precipitated as a pasty, perfectly white mass. The subsequent desiccation of the guttapercha requires several weeks' exposure to the air, but is accelerated by trituration in a mortar.

Hair.—(1) The hair is left for 12 hours in a solution of 3 parts carbonate of ammonia in 100 water at 86° F. (30° C.), then washed, washed again in soap, and completely scoured with another solution of carbonate of ammonia. The hair is afterwards dipped in the solution of peroxide of hydrogen, which has been completely neutralized with ammonia. The hair is either left in the bath until sufficiently bleached, or it is taken out, dried by ordinary temperature, and retaken through the bath. To ascertain if the baths have become useless for further work, a few drops of permanganate of potash are added, and if the bath takes a permanent red colour its bleaching power is exhausted. Black hair is not bleached to perfection, it can only be bleached to light gold-yellow. The hair is then washed in water, and can be treated with alcohol. Warm solution and drying in hot air are to be avoided.

(2) A recipe stated to bleach human hair white instead of blonde or yellow. Mix 1 lb. hydrogen peroxide with 1 oz. ammonia; mix 4 oz. hydrogen peroxide with 1 oz. cream of tartar dissolved in 1 oz. soda. Blend the two solutions, and steep 1 lb. of the hair in it for 3 hours. Then wash in clean water with "soapine" in a bath of pottery or clay, and thoroughly dry. Repeat the process 15 or 16 times; but thoroughly mix and shake up the hair after the 12th and every succeeding time. Finally, draw the hair through a solution of blue aniline and alcohol.

(3) A hot dilute solution of nitric acid is most effectual. Brown hair, when carefully treated, is turned the most brilliant golden, resembling golden spun glass. The method employed is to put the hair in a porcelain dish with dilute $NO_2\,HO$ (about 1 part strong acid to 10 of water), then gradually heat, and, as soon as the required shade is obtained, take out and wash. If the acid is too strong, or the heat too great, the fibre of the hair is spoiled. Dark-brown hair acquires generally a reddish colour, and black hair will turn nearly white.

Ivory.—(1) Ivory that has become yellow by exposure can be whitened by washing in a solution composed of 1 oz. of nitric acid and 10 oz. of soft water; apply with a rough brush; cleanse thoroughly in clean water; (2) or by rubbing the ivory with fine pumice and water, and while damp exposing it to the sun under a glass vessel.

(3) Peroxide of hydrogen is used in Sheffield to bleach the inferior ivory for knife handles. The mode of procedure is as follows:—Place, say, 2 qt. of the liquid in a stone pot, adding 4 oz. liq. ammon. fort (880°), immerse the handles, and put over a common shop stove for 24 to 36 hours; the handles are then taken out and gradually dried in the air, not too quickly, or they would split. The deep colour of the ivory is removed, and a beautiful pearly white ivory results when polished. The ivory is previously treated with a solution of common soda, to get rid of greasy matter, and open the pores.

Jute.—(1) The question of bleaching jute without injury has been studied for a long time. All bleachers have boasted of being able to bleach it as well as, or even better, than linen and hemp, but all have found that the bleaching was more apparent than real, and that the goods, after lying some months in the warehouse, turned from white to yellow, and no longer offered any resistance. Several manufactuers, for want of anything better, have been content with giving the jute a cream shade, and for this purpose they make use of rollers over which the hanks are hung, so that their lower ends dip into a weak chloride bath, very slightly warmed, for 30, 40, or 50 minutes. The hanks are then passed into water, pressed and dried in the air.

The treatment of jute by complete submersion, air being excluded, is the safest. Treatment on the roller with the intervention of air is the most dangerous. The reason of this is that in the former case the bleaching is a slow oxidation, whilst in the latter it is the result of the rapid and energetic action of hypochlorous acid. It has been tried, but without much success, to use silicate of soda and chloride of soda; chloride of lime is preferable. But to get good white it is necessary to steep the jute alternately in a soap-bath, and in a solution of chloride of lime. The following are directions for a so-called cream shade:—Immerse in a weak and lukewarm soap-bath for about 10 minutes; after draining, immerse for 40 minutes at most, in a bath of chloride of lime, not marking more than ½° on the chlorimeter.

The duration of the immersion may be variable, the quality of the jute and the shade which it is wished to obtain being the best guides. As for whites more decided than cream shades, they are produced in the same manner, but the duration of the steepings in the soap-lye and the chloride of lime is shortened, and these operations are repeated several times in succession. Whatever may be the shade at which the process is brought to an end, it is well to finish with two washings, the one in lukewarm and the other in cold water. The jute is then drained and dried at as low a temperature as possible. It is recommended that during the steeping process the jute should be regularly but gently agitated, taking care not to bring it above the surface of the liquid.

(2) According to Scheurer, chloride of lime was at one time considered suitable for jute bleaching, but it was soon found that this reagent made the yarn hard and brittle, likewise removing, along with a portion of its solidity, that silky brightness which constitutes one of its principal merits. Hypochlorite of soda, on the contrary, by reason of the more rapid and uniform oxidation which takes place, can be employed at a high degree of concentration without the resistance of the fibre being impaired. Its action has, however, to be regulated with care, on account of its powerful properties as a reagent. Bleached jute would suffer by being plunged into a concentrated solution of hypochlorite of soda, while such is not the case with jute in the unbleached state, in which the cellulose is protected in the earlier stages of the operation by the incrusting substance. It is the latter portion of the process (specially affecting the purification of the white) which is usually found to affect the solidity of the textile substance under treatment, even when the solution has not been a strong one. Therefore, Scheurer considers that, to save the fibre from the corrosive action of the hypochlorite, it is necessary to diminish the force of the reagent, as the operations succeed each other, and to preserve a certain relation between the degree of concentration of the oxidizing liquid, and the quantity of the encrusting substance which remains to be destroyed. In this way a satisfactory white is obtained, without prejudice to the textile substance operated upon.

(3) According to a patent taken out by T. G. Young, the jute is first soaked in a solution of a sulphide of an alkali, or alkaline earth, 'till sufficiently softened. It is then washed and submitted to a bleaching agent composed of a solution of chlorine and an alkali, other than chloride of lime, such as chlorine and soda, until the desired bleaching results are obtained.

Linen.—The same remarks apply here as to Cotton bleaching. (See Spons' 'Encyclopædia,' p. 515.)

Oils and Fats.—Many plans of decolorizing oils are in vogue:—(*a*) Exposure to sunlight in large white glass bottles; the oil soon becomes colourless, but acquires an almost rancid flavour. (*b*) Agitation with 2 per cent. of a solution of permanganate of potash; bleaches effectually, but also leaves a bad flavour. (*c*) The oil is first agitated with water containing gum, and to the emulsion thus formed, is added coarsely crushed wood-charcoal; the whole is then slowly warmed to a degree not reaching 212° F. (100° C.), and when cold, the oil is dissolved out by ether or petroleum-spirit, and the latter is recovered by distillation; the result is good. (*d*) A process much recommended is to pass nitrous acid gas through the oil. (*e*) The oil (500 parts) is clarified by addition of 50 parts of China-clay and 50 of water. (*f*) In some cases, it is found advisable to use the coagulation of albumen in clarifying oils. The oil to be treated is mixed by agitation at the ordinary air-temperature with a weak solution of albumen in water. The whole is then gradually heated, most conveniently by steam, and when hot enough to coagulate the albumen, this latter collects in clots, enclosing particles of impurity; after the lapse of sufficient time, these clots subside, and the clarified oil is removed by decantation. The process is analogous to that of the refining of syrups by serum of blood.

Many oils are partially or completely decolorized by filtration through, or agitation with, freshly-burnt animal-charcoal (bone-black). The apparatus for filtering is similar to that employed in sugar-refineries, and consists essentially of tall wrought-iron cylinders filled with bone-black, and provided with a steam-jacket to control their temperature. When the charcoal ceases to decolorize, it should be treated with some solvent (bisulphide of carbon, or petroleum-spirit) to remove the oil, before it is revivified by calcination.

Most processes for the bleaching of oils depend upon the oxidization of the colouring matter by some suitable reagent, chiefly evolving nascent oxygen in some form. There are, however, instances known in which the colour is destroyed by a reducing agent, such as sulphurous acid, in an aqueous solution, as gas, or arising from the decomposition of an alkaline hyposulphite (e. g. that of soda) by a strong mineral acid. It may be laid down as a general rule that oils which have been burnt or charred by any previous process cannot be satisfactorily bleached. Experiment alone can determine the particular process best suited to any given oil, having regard to the purpose for which it is to be used. The utmost care is required in using any oxidation process for fats intended to be converted into soap, since if the fat be oxidized in any perceptible degree, as well as the colouring matter (i. e. if too much of the bleaching reagent be used), the resulting soap will often be worse in colour than if the fat had not been bleached at all.

Palm-oil and tallow are the two chief fats bleached by the soap-maker. Both may be bleached by pumping air into them in finely divided streams, while they are kept at about 180° to 200° F. (82° to 93° C.). The colour of tallow may also be removed by boiling upon a solution of chloride of lime, or of chlorate of potash, to which a strong mineral acid has been added. No more potassic chlorate than 0·1 per cent. on the tallow should be employed.

Experiment has shown that the colour of palm-oil may be quite destroyed by heat. To effect this, the oil may be kept for some hours at about 260° F. (127° C.), or it may be put into a closed, horizontal, iron cylinder, and heated by a fire beneath up to about 464° F. (240° C.), at which temperature the colour is destroyed. This process gives rise to most offensive vapours, especially acrolein, and necessitates the conduct of operations in a closed vessel, with suitable means of condensing the vapours and rendering them innocuous.

Palm-oil may also be very suitably bleached by bichromate of potash and hydrochloric acid (Watts' process). The oil is made as free as possible from impurities, and, at about 120°–130° F. (49° to 54° C.), is agitated with a strong solution of bichromate of potash, containing about 1 lb. of the salt to every 100 lb. of oil. To this is added enough hydrochloric acid to form sesquichloride of chromium with all the chromium in the bichromate of potash, the quantity of liquid acid necessary of course varying with the amount of real acid contained in it. A slight excess of acid is rather an advantage than otherwise. The process occupies about an hour, after which, subsidence removes most of the chemicals, while subsequent agitation with hot water renders the oil quite pure enough for the soap-copper. (Spons' 'Encyclopædia.')

Paper pulp.—(1) The washed substances are put into a weak bath containing 6¼ to 8 lb. bleaching powder per 22 gal.; after 6 to 12 hours they are washed and boiled for 2 to 4 hours with carbonate of soda (1 oz. per gal.). If the fibres are very hard, they are treated with sulphuric acid (⅓ oz. per gal.), and well drained before boiling with the soda. Finally they are placed in a bath of 6¼ to 8¼ lb. of bleaching powder and 1¾ lb. of soda per 22 gal. for 4 to 6 hours. (2) The fibres are passed through an alkaline chlorine bath, containing excess of caustic alkali; 5 per cent. is used for linen, cotton, &c.; 25 per cent. for jute and other substances difficult to bleach. The temperature should not exceed 122° F. (50° C.). The bath is readily made by adding excess of soda carbonate to chloride of lime.

(3) Gas-bleaching half-stuff is almost indispensable for the coarse linen rags so plentiful in Russia. The half-stuff must contain sufficient moisture, or the outside only will be bleached, and that but indifferently. An effective test of the moisture is to squeeze the stuff between the hands, when, if the pressure causes no escape of water, but leaves the mass with a damp appearance, bleaching may be proceeded with. It is conducted as follows:—Put 1600 lb. of the half-stuff loosely into a stone chamber, and lute all apertures. Into the leaden retort, connected with this chamber by leaden pipes, pour 3 pails of water and 66 lb. of common salt; stir thoroughly, add 65 lb. manganese, stir again, and close the retort. Next charge a leaden vessel with 119 lb. oil of vitriol, and let the acid drop into the retort containing the water, salt, and manganese, through a bell-mouthed bent siphon, which admits the vitriol while preventing the escape of gas. The acid should occupy 3 hours in dropping into the retort. Then heat the retort with steam for 7 hours, and allow 2 hours for the gas to escape up the factory chimney. For fine stuff, such as "willowed" rope, 1 hour extra must be allowed for the escape of the gas. The quantities of manganese, salt, and oil of vitriol used for the various "stuffs" (see Paper) are:—

No. 1. (1600 lb. half-stuff): 50 lb. manganese, 50 lb. salt, 80 lb. vitriol.

No. 3. (1600 lb. half-stuff): 60 lb. manganese, 60 lb. salt, 100 lb. vitriol.

No. 4. (1600 lb. half-stuff): 65 lb. manganese, 66 lb. salt, 119 lb. vitriol.

Ropes, for copying paper (1400 lb. half-stuff): 81 lb. manganese, 91 lb. salt, 124 lb. vitriol. (Dunbar.)

(4) For potching half-stuffs previously gas bleached, the quantities are:—

No. 1. (600 lb. stuff): 15 gal. chlorine at 4½°.

No. 3. (600 lb. stuff): 20 gal. chlorine at 4½°.

No. 4. (500 lb. stuff): 12 gal. chlorine at 5°.

The quantities of half-stuff filled into the potching engine should be uniform. When the engine is filled, wash for some time with a finer wire than is used on the breaker. When thoroughly washed, raise the washer, and introduce the bleaching liquor. In the case of vitriol (concentrated sulphuric acid) being used, a small leaden vessel must be placed in such a position that the vitriol will drop into the engine at the rate of 1 lb. in 20 minutes. The vitriol is previously diluted. When the bleaching is finished, the stuff is emptied into stone chests fitted with perforated zinc strainers at the bottom and back, and left for a fixed time. (Dunbar.)

Paraffin.—The crude paraffin is filtered, and boiled for 2 hours with 5 per cent. of its weight of sodium sulphide and sufficient water. It is allowed to cool, so that the mass swimming on the top may become compact and be removed; it is then washed with river water, pressed, and afterwards dissolved in 20 per cent. amyl-alcohol, the paraffin being left as a pasty and pliable mass. It must remain for a time, and then be strongly pressed after filtering through bone-black. (De Molon.)

Rags.—The bleaching of rags may be conducted like that of Esparto (see p. 31). In addition, the methods of gas-bleaching and sour-bleaching are sometimes resorted to. The former, on account of the great inconvenience due to escape of chlorine, is rarely used; the operation may be carried on in large chambers of brick and cement or stone, with a tight-fitting cover, connected by a stoneware pipe with the apparatus for generating the chlorine. This last is obtained by heating black oxide of manganese with hydrochloric (muriatic) acid, or a mixture of oxide of manganese and salt with sulphuric acid. Sour-bleaching consists in alternate treatment of the rags with bleaching liquor and a weak acid, usually in large chests, or drainers. In some mills, the half-stuff is first well soaked with the bleaching liquor, and then weak sulphuric or muriatic acid is run in, in others, the reverse order is observed. The most economical plan apparently would be to first bleach as much as possible with the liquor alone, and then to add an acid when this is nearly exhausted. (Spons' 'Encyclopædia,' p. 1492.)

Shellac.—(1) By exposure in thin threads to the atmosphere.

(2) 1 lb. of shellac is dissolved in 4 lb. of very strong alcohol, 1 lb. of bleaching powder—containing at least 20 per cent. bleaching chlorine—mixed into a paste with water, strained through linen, and the residue washed with water until the filtrate amounts to 1 lb. It is then mixed with a solution of carbonate of potash in 3 parts of water until no further precipitate is produced. The precipitate is separated by filtration, the warm alcoholic solution of shellac is treated with hydrochloric acid until the mixture is decidedly acid. The shellac then separates as white clots, which are to be washed until the water ceases to pass away milky, and then rolled out into thin strips upon a wet board.

(3) The shellac, previously broken into small pieces, is put into a flask, alcohol of 0·830 sp. gr. is poured upon it, and the whole is gently heated till the shellac is dissolved; next, so much coarsely powdered animal-charcoal is added to the solution that the whole forms thin paste; the flask is closed almost air-tight, and exposed to gentle heat (e. g. the sun); in 8 to 14 days it should have a light yellowish-brown colour, and yield a clear pure polish on light woods. It is then filtered through coarse blotting-paper, for which purpose it is well to employ a tin funnel with double sides. The portion which first passes through the filter may be preserved separately, and used as a ground or first polish. Then some more spirit is poured over the charcoal upon the filter, and the solution used as a last coating. Shellac purified by animal charcoal has a brown-yellow colour, but is perfectly clear and transparent; when diluted with alcohol, the colour is so slight that perfectly white wood may be polished with it.

Silk.—(1) Lyons process. The bleach is an *aqua regia*, prepared by mixing 5 parts of muriatic acid with 1 of nitric acid. Before being used, the mixture is left for at least 4 or 5 days at a gentle heat, about 77° F. (25° C.). When it is to be used, it is to be diluted with about 15 times its measure of water, so as to stand at 3° to 4° Tw. This dilution is effected in large square tanks, cut out of grit-stone. The temperature of the liquid should be between 68° and 85° F. (20° to 29½° C.). The skeins being placed upon rods, they are plunged into the bath and worked without stopping, turning them quickly or drawing them from one end of the trough to the other. The process is generally complete in ¼ hour; but it is often at an end in 10 minutes and even less, according to circumstances. As soon as the bleaching is complete, the silk must be taken out, for a too prolonged stay in the acid would be very injurious. After being partially decolorized, it would next be dyed yellow, and in a permanent manner. This treatment, therefore, demands great care. Silks of different kinds should never be treated together, as they do not bleach with the same speed. As soon as the desired effect is obtained, the silks are withdrawn and immersed successively in 2 troughs full of water, in order to remove every trace of acid without delay. They are then ready for stoving. Some prefer to work in the cold, as safer, though slower. Guinon, Marnar, and Bonnet employ, instead of the *aqua regia*, a bath soured with nitro-sulphuric acid, i. e. sulphuric acid which has been allowed to absorb nitrous vapours (or a solution of chamber crystals). Chlorate of potash is also used with mineral acids.

(2) The method with peroxide of hydrogen is :—The silk is first treated with soap baths, and then boiled with concentrated soap solution, in order to deprive it of its gum. It is then treated with carbonate of ammonia. The process for bleaching is the same as that for bleaching hair (q. v.). After bleaching, a treatment in alcohol, to which some glycerine has been added, is recommended.

(3) Guinon proposes to bleach Tussah silk by steeping in soda-lye at 3° B., and at the heat of 212° F. (100° C.). It loses its gum and 12 per cent. of its weight, and is rendered white without loss of lustre. The treatment must not last longer than ½ hour. The silk is then washed, and passed through dilute sulphuric acid. The fibre is not injured, but the affinity for colours is reduced.

(4) Palangié and Bedu are inventors of the following process for depriving raw Tussah silk of its natural colour, and rendering it capable of being dyed in all shades by ordinary methods:—The silk, after being deprived of its skin by the ordinary method, is entered into a bromine solution of a degree of concentration varying with the colour of the silk. In this bath it is left for ½ hour. The silk is then entered into a bath containing a dilute solution of an acid, and in this it is also left for ½ hour. Several bromine and acid baths may be necessary. Tartaric and citric acids give the best result. They can, however, be substituted by alkaline solutions, of which carbonate of soda is considered the best. Sulphides and acid sulphides and also sulphurous acid can be employed for the second bath.

(5) Lecouteur and Girard's method of bleaching Tussah silk. For 1 lb.: In a cold oxygenated bath (35 pints ammonia, ⅛ volume oxygen) the silk is left for 24 hours. The bath is then heated up to 122° F. (50° C.) and kept for 12 hours at this temperature. The same operation is repeated with a new bath, after which the silk is washed in a soap bath and rinsed with cold water. A bath containing binoxide of barium in suspension, through which carbonic acid is passed, after addition of a little bichromate of ammonia, gives the same results.

(6) The following is a summary of Moyret's remarks on silk bleaching :—

Silk yarn. Scouring with weak caustic alkalies.—These, viz. caustic potash and soda (caustic ammonia has no action), are the most active, but, at the same time, the most dangerous, to employ, since with prolonged action, especially in the case of fine silks, the fibre itself is attacked. They are used, however, and with success too, for scouring the coarser and fancy kinds of silks. The hanks of silk are hung on sticks, and worked in a tub containing the scouring liquor, as in woollen yarn scouring. For 100 lb. silk, a solution of 3 to 4 lb. solid caustic alkali in about 300 gal. water heated to 140° F. (60° C.) is used, and the yarn is turned during ½ hour. It is then well washed and beaten. This plan is advantageous for coarse fancy silks, since it dissolves off the fine down of the fibres. For these qualities, the total loss in scouring is 10 to 12 per cent. of the weight of raw silk.

Scouring with Alkaline Carbonates.—This method, still used in China, has, notwithstanding its economy, almost entirely disappeared from European establishments on account of certain practical difficulties. The silk yarn is worked for 1 to 1½ hour, in a bath heated to 185° F. (85° C.) containing for 100 lb. silk, 10 to 12 lb. soda crystals. At first, the silk swells up and becomes gelatinous, then the outer envelope dissolves off, the fibre thereby becomes finer and more lustrous. It is sufficiently scoured when it produces a rustling noise on being rubbed with the nail; it is then washed 2 or 3 times with tepid water. The loss varies from 18 to 28 per cent. Besides the delicacy of this method, it is inconvenient not to be able to boil the silk without great risk, while experience has shown that boiling will give in many respects a better article.

Scouring with Soap.—This is pre-eminently the best method, since it preserves and even increases the valued properties of silk, such as feel, brilliancy, &c.; the soap used, however, should always be of the best quality. In the north of Europe, soft potash soaps, generally made from linseed oil, are used; in the south, hard soda soaps made from olive and other oils are preferred. Of late years, soap made from oleic acid has been more and more employed. Those soaps are to be preferred which wash off best and leave an agreeable odour. In general, those made from oleic acid and linseed oil wash off best; then follow the soaps made from olive oil, suet, &c. (containing stearic and margaric acids); last, and worst in this respect, comes palm-oil soap, which, on this account, has been almost entirely given up, notwithstanding its agreeable odour. For scouring silks which are to be subsequently dyed, oleic acid soap may be recommended; but for those destined to remain white, a good olive-oil soap is best. In the latter case, two operations are necessary, "ungumming" (*dégommage*), and "boiling." For "ungumming," a boiling solution of 33 lb. soap to 100 lb. silk is used, the yarn being worked in this, from ½ to ¾ hour. Previous to placing the silk in this bath, however, it should be softened in a weak solution of soda crystals, or better still, of hydrochloric acid, and should be washed. For "boiling," the same bath may be used (if not too strongly charged with silk-glue), except for the purest whites, or when the raw silk is coloured; in these cases, a fresh bath is imperative. The yarn is lifted from the ungumming bath, and allowed to drain; the hanks are then wrung, sewn up in coarse hempen bags or "pockets," and boiled, during 2 to 3 hours, with a solution of 17 lb. soap per 100 lb. silk. The yarn is then rinsed in a weak, tepid solution of soda crystals, to avoid the precipitation of any fatty compounds on the silk, after which it is rinsed in cold water. For Japanese and Chinese silks, the loss may vary from 18 to 22 per cent.; for European silks, 25 to 27 per cent.

Scouring with Acids.—Moyret finds that an aqueous soluthroat. (2) Or per cent. of phosphoric or [illegible]shed as has an action similar to that of the weak alkalies. Silk, previously moistened with dilute tepid hydrochloric acid to free it from lime, is ungummed, after boiling for 3 hours in the pockets with the above solutions. The process, however, has not been adopted, owing to the fact that the silk is not rendered so white, and is not so capable of being properly weighted afterwards.

Silk Yarn Bleaching and Tinting.—After scouring, the yarn is opened out, to be hung on sticks, and worked in a bath containing 10 lb. soap per 100 lb. silk, at a temperature of 120° to 140° F. (49° to 60° C.); it is then drained and straightened out, ready for being sulphured. The total amount of good olive-oil soap required to scour silk for white, varies from 50 to 60 per cent of the weight of the latter in the raw state.

Sulphuring.—For this purpose, the hanks, while still damp and well straightened out, are hung in the sulphur chamber (which is of the same construction as that for woollen bleaching), and are there exposed to the fumes of burning sulphur for 5 to 6 hours, or even over night. Afterwards, the silk is well rinsed in a weak tepid solution of soda crystals, in order to wash out the sulphurous and sulphuric acids absorbed by the fibre. To ensure the thorough expulsion of the former, it is customary to hang the rinsed hanks, after wringing out the water, in a stove heated to 85° to 100° F. (29° to 38° C.). With reference to the bleaching of silk by sulphurous acid, Moyret's opinion seems to be that probably it does not act directly in destroying the colouring matter of the fibre; but that along with the formation of sulphuric acid there is also a production of ozone.

Tinting.—This operation is necessary to hide the faint yellow hue which the silk still retains. Unlike the analogous operation in use with cotton and wool, the question here is not always one of simple blueing; to suit the tastes of the merchants, the silk is actually dyed in

(2) The [illegible], e. g. milk-white, [illegible] (pure white), azure-white (blueish-white), Chinese white (orange, yellowish and purplish whites). To obtain pure white, a very weak neutral bath of ammoniacal cochineal and indigo carmine is used, care being taken that the dye should not too rapidly fix itself on the fibre; to prevent this, a little ground chalk is added to the bath. A cold or slightly tepid solution of aniline violet, with addition of a little soap, is also very much used for this shade. To obtain Chinese white, a weak soapy solution of annatto may be employed. After tinting, the silk is rinsed in fresh water and dried in a moderately warm stove, admitting as little light as possible. A passing reference must here be made to the wild or Tussah silk, which it is not possible to bleach in the ordinary way; the process of Tessié du Mothay, however, yields very fair results.

Scouring and Bleaching Woven Silk.—Before scouring, the goods are singed with the gas flame (as in cotton bleaching). The scouring machine consists simply of a winch set over a wooden box or tub. As with the silk yarn, so here, there are two operations, "ungumming" and "boiling," both of which can be done with the same machine. For ungumming, the piece is simply winched backwards and forwards, for about an hour, in an old boiling liquor at 212° F. (100° C.). After winding the piece on to the winch and allowing it to drip, the liquor is run off and the tub is refilled with fresh liquor, containing 30 to 40 per cent. of white soap, and heated to incipient boiling. The piece is then unwound, and again winched backwards and forwards for about 2 hours; it is then rewound on to the winch, and allowed to drip for ½ hour, when it is ready to be rinsed for dyeing in dark shades, or to be bleached for pale or white shades. Sometimes, in order to save time, the boiling is done in pockets as in the case of silk yarn. For rinsing, the winch with the silk wound on it is transferred to another tub containing a weak solution of soda crystals, where it is unwound and winched for ¼ hour, after which it is removed to be streamed in running water, and beaten, till thoroughly clean and ready for dyeing. If for sulphuring, a fresh weak soap bath heated to 120° F. (49° C.) is given, instead of rinsing; and, after draining, the pieces are hung in the sulphur stove. According to the degree of purity of white required, this soaping and sulphuring is repeated several times. (Spons' 'Encyclopædia.')

Silver Dials.—Clean the dial by any ordinary means, then black it over the flare of gas, continue heat till black burns off, then pickle in vitriol and water, 1 in 20.

Sponge.—(1) Saturate in a quart of buttermilk for 24 hours, and rub between the hands. (2) Soak in dilute muriatic acid (1 acid to 1½ water) for 12 hours, wash well with water, to remove lime, then immerse it in a solution of 2 lb. hyposulphite of soda in 12 lb. water, to which 2 lb. muriatic acid has been added a moment before. After it is sufficiently bleached, remove, wash again, and dry. (3) Soak for several days in cold water, renewing the water and squeezing the sponges occasionally. Then wash in warm water, and put into cold water acidulated with hydrochloric acid. Next dry, take out, and wash thoroughly in soft water; then immerse in an aqueous sulphurous acid (sp. gr. 1·034) for a week. Afterwards wash in plenty of water, squeeze, and allow to dry in the air. (4) Soak in dilute hydrochloric acid to remove the lime, then wash in water, and place for 10 minutes in a 2 per cent. solution of potassium permanganate. Their brown appearance on removal from this is due to deposition of manganous oxide, which may be removed by steeping for about 2 minutes in a 3 per cent. solution of oxalic acid, to which a little sulphuric acid has been added. As soon as the sponges appear white, they are washed out in water to remove the acid. Very dilute sulphuric acid may replace the oxalic acid. (5) First wash in tepid water, and then in a solution of hydrochloric acid (5 *cc.* per *litre* = 5 fl. dr. per 7 pints), which frees the pores from carbonate of lime; next immerse for 24 hours in a solution composed of 5 pints hydrochloric acid in 100 of water, with addition of 6 pints hyposulphite of soda. (Blondeau.)

Starch.—Potato starch is largely bleached by the application of sulphuric acid, this being absolutely requisite when the potatoes are at all decayed. After the use of the sulphuric acid, any remaining traces of acid must be neutralized by ammonia or milk of lime, fixed caustic alkalies being inadmissible. Chlorine is also much used for bleaching starch, usually as a solution of calcium chloride in water soured by the addition of sulphuric acid; this and some other salts cause the grains to swell, and render them soluble in cold water. Sal ammoniac is another favourite agent.—(Spons' 'Encyclopædia.')

Straw.—On a small scale, with such an article as a straw hat, a bonnet, a basket, &c., the following method may be followed:—(1) The straw, having been well washed with weak soda lye, is rinsed in plenty of clean water, lightly shaken, &c.; remove superfluous moisture, and place, supported on a stick, under a large glazed earthenware pan (turned upside down). A very small pipkin, capable of holding about ½ pint, is now placed on the fire, and about ½ oz. of roll brimstone placed in it. When the brimstone is all melted, a light is applied to it, so as to cause it to catch fire. The pipkin, with the inflamed sulphur, is now placed under the glazed pan in such a position as not to scorch the article to be bleached. The spaces between the pan and the table or floor on which it rests, must be carefully closed with damp cloths placed around to prevent the escape of the sulphurous acid gas, produced by the combustion of the sulphur. In about 2 hours the pan may be removed, when the straw will be found nicely bleached. N.B.—This operation had better be performed out of doors, as the sulphurous acid gas, which is set free on lifting the pan, is extremely irritating to the chest and throat. (2) Or the articles, having been washed as before, may be placed for an hour in weak chloride of lime water, and then hung out on a line to dry slowly. The chloride of lime water should be made by mixing 1 part (by weight) of chloride of lime with 20 of water, agitating the mixture with a stick until all the particles of chloride of lime are thoroughly broken up, allowing the mixture to settle, and pouring off the clear portion from the dregs for use. (3) In Tuscany, where a considerable amount of straw is bleached, the straw is selected while the wheat is bearded, and the grains still in a soft milky state. In order to ensure the requisite fineness, the corn is sown very thickly, so that the straws are in a dwindled condition. The straws are cut, spread out for 2 or 3 days, to dry out the sap, tied up in bundles and stacked to allow all moisture to dry off. They are then again spread out, exposed to the dew and atmosphere, turned over several times, and watered with clean water. After this, the lower joints are cut off, the chosen portions exposed to the action of steam in a steam vat, which further decolorizes them, and lastly bleached by exposing to sulphurous acid vapours in closed chambers. (4) In this country, the straw is prepared by acting upon ordinary materials; first, with a solution of caustic soda, boiling, by which a considerable portion of the organic matter and natural varnish is disintegrated; after this it is washed well to remove all the material which the alkali dissolves, and then exposed to the action of sulphurous acid or chlorine in closed vessels. (5) Kurrer states that straw may be economically whitened by being steeped repeatedly in boiling water and very weak alkali, and, after all the soluble matters are in this way removed, by treating alternately with very dilute solutions of chloride of lime and sulphurous acid vapour, until decoloration has been effected. This method, though tedious, is said to be very effectual for divesting the straw of its natural varnish, which renders it very brittle.

(6) About 9 oz. of permanganate of potash are dissolved in 1 gal. of warm water. This is done in an earthenware vessel, and cold water is then added until the liquid takes a dark-red colour. The straw is left for about 6 hours in a tepid and weak solution of soda crystals. It is then washed carefully and introduced into the permanganate solution, in which it is continually agitated. As soon as it has taken a light-brown colour, it is dipped in cold water, then in a bath of bisulphite of soda, strong enough to be smelled. In this bath the straw is left for 15 minutes, and when taken out it is perfectly white. (7) Soak the goods in caustic soda, and afterwards use chloride of lime, or Javelle water (chloride of potash). The excess of chlorine is afterwards removed by hyposulphite of soda (antichlor).

Wax.—(1) Melt the wax in a jar, and put into it powdered nitrate of soda (Chili saltpetre) in the proportion of 1 oz. to the lb. of wax; afterwards add, by degrees, 2 oz. to the lb. of sulphuric acid, diluted with 10 times its weight of water, keeping the wax warm and stirring the while. Let it stand a short time, and then fill up the jar with hot water, and allow the whole to cool. The wax should then be white. Afterwards wash with water to remove any nitric acid that may remain, as it would make the wax yellow.

(2) Melt the wax with about 3 per cent. of water in a bright copper vessel, preferably heated by steam, and when the whole is liquid, and has boiled for a few minutes, withdraw the heat. Then sprinkle over it some oil of vitriol in the proportion of 3 oz. or 4 oz. (fluid) to every cwt. of wax. Be careful in doing this, as if done carelessly the melted wax will froth up and boil over. The oil of vitriol should be scattered over the whole surface. Cover it over, and allow it to settle. Then skim it gently with a hot ladle and bale it into vessels to cool. Take care not to disturb the sediment. To bleach the wax, expose it in thin flakes to the action of the sun, wind, and rain. Sometimes it is advisable to change the surface exposed by remelting it, and again making it into thin flakes.

(3) Wax for candle-making is bleached by being melted in hot water or by steam in a wooden or tinned-copper vessel. It is allowed to settle, and the waxy superstratum is run off while fluid into a wooden trough, having a row of perforations in the bottom, by which it is distributed upon horizontal wooden cylinders revolving with their lower portions surrounded by cold water. The ribbons or fibres made in this way are exposed to the bleaching action of the atmosphere and sunlight, being frequently moistened and turned over during the process. It is necessary to guard against wind, which might scatter the shreds; hence large cloth covers are kept in readiness. The operation is continued till the wax becomes perfectly white. It is usually conducted in Britain between April and September, the weather not being propitious at other seasons. In France, it is customary to add a little cream of tartar or alum to the water in which the wax is melted, whereby the bleaching is much curtailed. Bleaching agents like chlorine render wax unfit for candle-making. (Spons' 'Encyclopædia.')

Wool.—The same remarks apply to the bleaching of wool and woollen fabrics as to cotton and linen. (See Spons' 'Encyclopædia,' p. 508.)

BOILER INCRUSTATIONS.—This subject, of such important interest to all users of steam, has been ably discussed by Rowan, in a paper read before the British Association in 1876.

Crace Calvert's previous experiments showed that iron and steel were rapidly corroded when simply immersed in sea-water. Iron immersed in water containing carbonic acid oxidized rapidly; but when subjected to the action of dry oxygen or dry carbonic acid gas, there was no appreciable action on the surface of the metal. In damp oxygen, there was sufficient oxidation to just call for mention; in damp carbonic acid, there was a formation of white carbonate of iron; a mixture of the two gases in the dry state produced no effect; but rapid oxidation occurred in the presence of damp oxygen and damp carbonic acid. Calvert also found that distilled water, free from air and as pure as could be obtained, exercised little effect upon iron, though it dissolved lead to a small amount; distilled water, aerated, acted, however, in a rapid manner upon lead. Wagner found that the presence of the chlorides of ammonium, barium, calcium, magnesium, potassium, and sodium in the water, more or less largely increased the production of rust, and he found also that the corrosive action of these salts was considerably stimulated if the water held in solution air and carbonic acid. Chloride of magnesium appears to be the most active agent of corrosion when alone, but combinations of the other chlorides are also very destructive, even when formed of those—e. g. barium, calcium, sodium—which singly have little or no corrosive action on iron at a temperature of 212° F. (100° C.). The presence of an alkali, however, such as ordinary commercial potash or soda, appears to protect the iron from the action of the water even in the presence of air and carbonic acid. But the most destructive agent appears to be distilled water in the presence of air and carbonic acid.

Summed up, Rowan's paper amounts to this: That it is the presence of air or gases in the distilled water, and also in the ordinary "pure" natural waters, which enables them to corrode the metal of the boilers in which they are used; but that when water is distilled free from air, it has practically lost all corroding power. This dictum strikes at the views of those engineers who suggest that the condensed steam should be aërated, and with equal strength at what is known as the aëro-steam-engine, Warsop's principle, in which air is forced into the boiler.

Land boilers are affected by corrosion equally with those used on board ship; but in the former case remedies can be applied which in the latter case are impossible. In marine boilers are found a variety of corrosive actions depending to a great extent on the use of fresh water, with more or less (or none at all) sea water. The only marine boilers using fresh water exclusively are Rowan & Horton's and Perkins', though some of the ordinary boilers have been occasionally tried with fresh water, the result being a rapid corrosion. Although fresh water is "exclusively" used in the patent boilers mentioned, it is found practically impossible to prevent a small quantity of sea water finding its way into them; but, in the absence of analyses, it is unknown to what extent this leakage takes place. Perkins seeks to exclude all sea water and all oil or grease of any kind, and if these desiderata can be attained, the corrosion cannot be of any great importance; but still there will, Rowan thinks, be some, for the condensation of the steam takes place in the presence of a small amount of air, and some of it is sure to be mixed with the water forced into the boiler. Stingl some time back made researches on the action of grease in steam boilers, and came to the conclusion that the fatty acids were potent factors in producing corrosion in steam boilers. Stingl not only demonstrated that the fatty acids were the cause of the rapid corrosion in a certain boiler, but by a process of purification and filtration of the same water he showed the exact amount of injury worked by them. In cases where grease reaches the boiler, it can also carry with it particles of other matters, and these, apparently by galvanic action, do mischief—a statement which, in spite of the incredulity of some engineers, Rowan considers is well established. In connection with some land boilers which used Glasgow water first, and afterwards Loch Katrine water, Rowan furnishes some interesting facts, from which it would seem that while "pure" natural waters act destructively upon boiler plates when used at starting a new boiler, they are innocuous when employed after the boiler has received a scale either from the previous use of a calcareous water or from lime pumped into it for the purpose. Thus a boiler at Port Dundas, which had been worked with ordinary hard river water, continued to work for years when supplied with Loch Katrine water, without showing signs of corrosion; but a set of new boilers at the same works, which were fed with Loch Katrine water from the commencement, required new tubes in a very short time. Similar results have been experienced elsewhere. The boilers in question were working high-pressure engines, so that no condensed water was fed to them, and neither grease nor other corrosive agent was put into them. Hence the effects observed are attributed solely to the water. Now, in Loch Katrine water there is nothing that can account for the corrosive action, save that it contains 7 to 8 cub. in. of gas to the gallon (about 3 of which are oxygen). It is a remarkably pure natural water, almost perfectly, soft, and containing no mineral matter with which the carbonic acid and oxygen can combine. The corrosion in the boilers in question was checked and prevented by feeding them each morning for a time with a wash of lime and water, for the lime, hardening on the plates from the heat, effectually preserved the iron from the effects of the pure water in the presence of carbonic acid and oxygen. Rowan quotes the cases mentioned by Miller, in one of which a set of boilers worked for 4 years with sea-water, using the injection condenser, exhibited no signs of damage either from incrustation or corrosion, sufficient time being allowed for "scaling" at the end of each voyage; but when the injection condenser was replaced by a surface condenser, and fresh water, supplemented by occasional supplies from the sea, was fed to the boilers, they speedily lost the protecting crust, and became corroded with pits and blotches in the well-known form. The explanation of the action is found by some in the belief that by repeated distillation the water becomes altered—that is, it is split up, the oxygen attacking the metal of the plates, while the hydrogen escapes. Rowan, however, points out that the water, in the case in question, never was genuine distilled water. It was fresh water to start with, supplemented by supplies of sea water, so that it always had a considerable amount of carbonic acid and oxygen in solution; and besides, when put into the boiler, it commenced to dissolve the chloride of sodium in the salt scale formed by the sea water. In short, Rowan's contention is, that the scale was dissolved off, and that the "distilled" water containing air accordingly was free to attack the iron. But when sea water is introduced into boilers as a supplementary feed, the plates, being clean, are liable to be damaged by the action of hydrochloric acid set free by the decomposition of chloride of magnesium. It is also not improbable that carbonic acid is set free by the mutual decomposition of sulphate of magnesia and carbonate of lime; hence the action of these acids, combined with high temperature and pressure, is sufficient to account for most of the corrosion, in Rowan's opinion.

As to the suggested remedies. Zinc has been shown, especially on the Continent, to be an excellent anti-corrosive in those cases where decomposed grease, or fatty acid, is the destroying agent; but its usefulness is confined to land boilers, or to those marine boilers in which fresh or distilled water is alone used; for zinc is attacked by sea water, and chloride of zinc is formed, and would, if the assumptions above made are correct, merely add to the impurities and evils to be avoided. Filtering the feed is an excellent precaution, and should be universally adopted; but to prevent the corrosive action in marine and other boilers of substances which no filtering can arrest, Rowan thinks nothing better can be suggested than forming on the interior surfaces an *artificial coating of calcium sulphate* and magnesium hydrate, in proportions varying with the pressure carried in the boiler. The mixture can be easily fed in in the form of a thin whitewash with fresh water; but to obtain the best results it should be supplied at the commencement of the boiler's career, before corrosion has unfitted the surfaces of the plates for the adherence of the protective coat. It is claimed that when once hardened by heat, the artificial scale thus made with fresh water cannot be dissolved by fresh water, and is not likely to be affected by the small quantity of sea water which may leak in; that its thickness is quite under control; and that it is safe and free from the trouble attending the keeping up of a salt scale.

A writer in *Le Technologiste* discusses the processes employed to prevent boiler incrustations under 3 classes:—(1) chemical, (2) chemical and mechanical combined, (3) physical.

Chemical Processes.—These consist in the use of certain solvent substances introduced into the boiler to precipitate salts contained in the water. The non-adherent, muddy deposits thus formed from the calcareous matter are from time to time removed, that they may not by their presence be an obstacle to the action of heat. Colouring matters, dyewoods, and in general all woods containing tannin, can be used for the purpose, when the waters contain neither sulphates nor chlorides. Various other products having for base fecula, lime, and baryta, are also employed with success; but the constitution of the substances used should be suited to the nature of the water. The chief inconvenience in using these products is that most of them corrode the boiler-plates, and produce a froth in the water with which they are mixed, containing precipitated fragments, which, in consequence of their small size, are readily carried by the steam into the valves and cylinders of the engine, where they may injure the joints through friction, and cause an escape of the steam.

Chemico-Mechanical Processes. — In the processes just referred to, it is of course necessary to open the boiler in order to remove the deposits, and this may sometimes require a stoppage of work for an entire day. This disadvantage would be obviated if, instead of putting the anti-calcareous matters into the boilers, they were put in the feed water, and this water filtered (after heating) before being introduced into the boiler. The Chemin de Fer du Nord Co. have used apparatus of this kind for several years, the precipitating matters being mixed, by mechanical agitation, with the feed water in large reservoirs. When the mixture is sufficiently complete, the muddy water is decanted during 10 or 12 hours, and filtered previous to use.

Physical Processes.—By heating the water to a high temperature, it is possible to purify it from all the sedimentary matters contained in it. These matters are decomposed and precipitated, and cannot adhere to the walls of the vessel containing them till the temperature of the water is lowered. The temperatures at which the calcareous matters are precipitated are the following:—

Carbonates of lime, between 176° and 248° F. (80° to 120° C.).

Sulphates of lime, between 284° and 302° F. (140° to 150° C.).

Chlorides of magnesium, between 212° and 257° F. (100° to 125° C.).

Chlorides of sodium, between 302° and 320° F. (150° to 160° C.).

When the water contains only carbonates of lime, it suffices to heat to a temperature of about 212° F. (100° C.), which may easily be obtained from the exhaust steam of the engine, and with ordinary air-pressure. When the water contains sulphates of lime or chlorides of sodium or of magnesium, as sea-water, it must be raised to a higher temperature, which has to be obtained by heating under pressure. In this case, the steam must be taken from the boiler—a fact which proves obstructive to the general use of such apparatus.

In the Alsace Society of Engineers it was mentioned, not long ago, that the gases proceeding from a furnace which was furnished with heating-pipes had a temperature of 194° F. (90° C.). These pipes received water at a temperature of 68° F. (20° C.), and this water was heated by the difference of temperature of the external gases and the water, viz., 70° C. It is evident that if, in this work, a dejector apparatus had been employed to heat water to 302° F. (150° C.), there would have been a considerable excess in expenditure of fuel; it would no longer have been the gases which heated the heating-pipes, but the water in the heating-pipes which heated the gases.

This constitutes the principal objection to such apparatus. Wherever boilers are heated directly without return of flame, such as the Field and Belleville boilers, it is not disadvantageous to employ them. It might happen that the economy of fuel arising from the absence of calcareous deposits in the interior of boilers (as in tubular boilers) would compensate, or more than compensate, for the defects just pointed out. Careful experiments could alone determine this. A few special forms of dejector apparatus will now be described.

Dumery's Dejector.—This apparatus is based on the principle that in a liquid which is in general ebullition, all the substances in suspension in the mass are, while the ebullition lasts, carried to the surface and remain there. The mode in which Dumery removes these foreign substances will be understood from Figs. 6 and 7. The dejector consists of an iron cylinder, having at its upper part vertical ribs, in serpentine form, against which the water circulates. These terminate in a horizontal disc, which forms, with them, closed passages. The water enters the apparatus by the tubulure A, and circulates about the partitions *a*, *b*, and *c*, passing out by the tubulure B. The water taken from the boiler at its upper part by means of a diaphragm, which causes it to be inflected horizontally, is restored to the boiler at its lower part; in passing among the partitions in the dejector it is freed of the foreign matters held in suspension. These matters, immediately on leaving the liquid vein, fall to the bottom of the apparatus, from which they can be easily removed by the stopcock *d*.

Lugand and Bassere's Dejector.—This simple apparatus (Fig. 8) consists of a cast-iron vessel, with a cover, which forms, with the sides of the vessel, an annular space. The injected water arrives by a tubulure, and traverses a plate pierced with small holes, which divide the liquid into threads, and these, in their fall, are acted on by full-pressure steam, which comes from a boiler, and fills all the space not occupied with water. The water is thus raised to a temperature of more than 212° F. (100° C.). The calcareous salts pass to the granular state, and are deposited at the bottom, whence they can be removed when necessary, and the purified water is decanted into the annular space, from which it passes out by a tubulure to the lower part of the boiler. To avoid loss of heat, the apparatus is surrounded by some non-conducting substance.

Farinaux's Dejector.—This consists of a vertical column, A (Fig. 9), containing a series of dividing discs, B; the water is injected at the upper part, and passes successively through all the plates before reaching the vessel C, where it is decanted. In the passage through the plates it is divided into a great number of streamlets, which are heated by steam coming from the boiler through D. The water, heated and decanted, leaves the apparatus by E. The chief difference between this apparatus and the preceding consists in the increased number of plates.

Potez's Dejector.—This is shown in Figs. 10, 11, and 12, and, like that of Farinaux, contains a column A, with a number of perforated discs *d*. In the interior of the column is a vertical pipe *s*, which crosses the discs, and serves for the escape of the water. Steam enters the apparatus by the orifice *r*, and meets the water which arrives at the base of the column by the orifice *e*. This water passing upward through the series of discs, traverses a filter, and descends by the central pipe *s*, while a quantity of steam collects in the chamber at the top. The extraction of deposits from the apparatus is effected by the orifice D. Potez sometimes places his apparatus in the interior of the cylindrical body of the boiler, as shown in Fig. 12. (*English Mechanic.*)

It would be impossible (and not very instructive) to enumerate all the substances which have been suggested for preventing boiler incrustations, from dead cats upwards. But a few remarks from various authorities may convey some information.

FIG. 6.

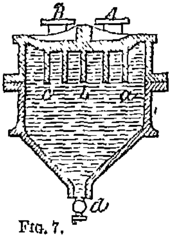


FIG. 7.

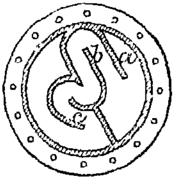


FIG. 9.

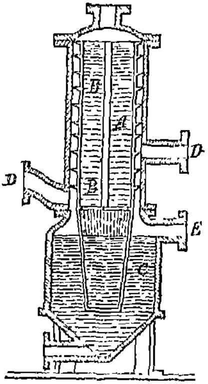
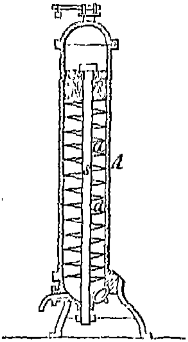


FIG. 10.



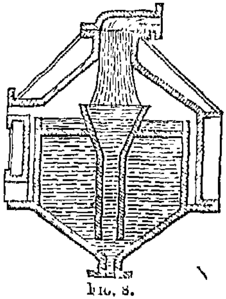


FIG. 8.

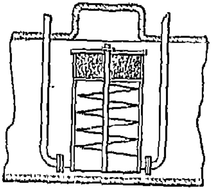


FIG. 12.

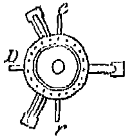


FIG. 11.

The minister of public works in France recently ordered an investigation into Lesueur's method of preventing boiler incrustations. This consists in introducing into the boiler some small ingots or clippings of zinc; it is then observed that the usual earthy substances, instead of forming a hard and adherent deposit, form a non-coherent crust, which can be readily removed. If the water be very strongly impregnated with lime salts, the deposit, even if coherent and solid, does not adhere firmly to the boiler plate. The zinc is converted into a white earthy mass, principally oxide of zinc. No trace of zinc can be detected in the water, and there is very little in the ordinary incrustation, as the oxide of zinc forms a separate deposit. Experience has shown that about 2 lb. of zinc per month per horse-power is sufficient. The action of the zinc, being in contact with the iron boiler plate, is probably electrical, and, if hydrogen be evolved in small bubbles, it would be sufficient to account for the deposit *being non-adherent and friable.*

G. E. Davis, inspector of chemical works, draws attention to the fact that the incrustation of the inner surface of a boiler is frequently caused by the use of *water which would not be suspected* of any such power, and points out the danger of using water which has been condensed from the boiling down of organic substances. Many nostrums have been brought forward, and *claims* made on their behalf that they would prevent incrustation, but most are absolutely worthless, if not injurious. Boiler "scales" nearly everywhere are principally composed of sulphate of lime, and he made a number of experiments to try and find some substance which should neutralize the action of that substance on the boiler plates. After many trials, he came to the conclusion that tribasic phosphate of soda, known to commerce as "tripsa," is the best of all preparations. It absorbs the free carbonic acid in the water, and, acting upon the sulphate of lime, precipitates it with the mud to the bottom of the boiler. In one case where this preparation was used, the boiler was worked for 5 months without being cleaned, and only the very slightest deposit, which could be easily displaced *by a touch*, was formed.

J. Waugh asserts that neither compounds, glycerine, nor galvanic action will prevent incrustation, and that the best course is to have a separate vessel *in which to heat the water before it* passes into the boiler. In this way the feed water can be raised to a temperature of 212° F. (100° C.), and afterwards to 300° F. (149° C.); and while the carbonates of lime and magnesia will be precipitated in the one vessel, the sulphate of lime will be precipitated in the other—the result being that, however impure the water, there will be no incrustation.

Dingler's Polyt. Journal, says, A boiler with clean plates yielded with 1 lb. coal 7·5 lb. steam, after two months only 6·4 lb. steam, or a decrease of 17 per cent. At the same time the boiler had suffered by continual working. *Suppose a boiler free from inside crust* would yield a saving of only 5 per cent. in fuel (and this figure is taken very low compared with practical experiments), it would be at the same time a *saving of 1½d.* per cub. yd. of water. If the cleaning of 1 cub. yd. of water therefore costs less than 1½d., this alone would be an advantage. For a long time, efforts have been made to find some means for this purpose, and we have reached good results with lime and chloride of barium, as well as with magnesia preparations. But these preparations have many disadvantages. Corrosion of the boiler iron and muriatic acid gas have been detected. Chloride of calcium, which is formed by using chloride of barium, increases the boiling-point considerably, and diminishes the elasticity of steam; while the sulphate of soda, resulting from the use of carbonate of soda, is completely ineffectual against the boiler iron. It increases the boiling-point of water less than all other salts, and diminishes likewise the elasticity of steam. (Wullner.)

In using magnesia preparations the precipitation is only very slowly and incompletely effected—one part of the magnesia will be covered by the slush and the formed carbonate of magnesia in such a way, that it can no more dissolve in water and have any effect (*Dingler's Polyt. Journal*, 1877–78). The use of carbonate of soda is also cheaper than all other above-mentioned substances. One *milligramme equivalent sulphate of lime* in 1 *litre* = 68 *grm.* sulphate of lime in 1 *cub. m.* requiring for decomposition: 120 gr. (86–88 per cent.) chloride of barium of commerce—cost, 0·6*d.*

Or 50 gr. magnesia preparation—*cost*, ½*d.*

Or 55 gr. (96–98 per cent.) carbonate —cost, 0·41*d.* The proportions of cost by using chloride of barium, magnesia preparation, carbonate of soda will be 6 : 5 : 4.

By far the most important recent

addition to existing information on the subject of boiler-incrustations is contained in a paper read by W. Ivison Macadam, before the Society of Chemical Industry, on the results of examinations of the chemical composition of steam-raising waters, and of the incrustations formed from them, with notes on the action of the materials commonly used as anti-incrustators, and on the various processes for softening water for steam purposes. Following is an abstract of the main facts.

Waters used for steam-raising purposes generally contain much solid matter in solution, and not unfrequently insoluble materials in suspension. These solid constituents, whether in solution or suspension, consist partly of salts and are partly organic in nature. The waters are derived from many sources, springs or rivers, pit discharges, sewage, sea water and surface water. The following analyses show the chemical composition of some samples.

From these results it is seen that the waters usually hold in solution much saline matter, and are divisible into (1) those containing calcium carbonate, and (2) those having a proportion of calcic sulphate in solution. The pit waters, especially those obtained from shale and coal seams, frequently contain large amounts of the acid sulphates of iron and alumina, and prove most hurtful to iron plates. Sewage impregnated waters have a considerable proportion of oily and fatty matters,

Table A.—Waters obtained from Rivers and Loch.

—	River.	Loch.	River.	River.
	gr.	gr.	gr.	gr.
Total Saline Matter	2·56	1·28	4 72	9·92
Total Organic Matter	0·68	0·36	1·16	4·46
Total Solid Matter ..	3·24	1·64	5·88	14·38
Chlorine	0·50	0·25	0·25	0·75
Calcic Carbonate	0·98	0·36	1·46	4·06
Calcic Sulphate	0·22	0·22	0·43	0·36

Table B.—Waters obtained from Wells.

—	Town Supply, Rain Water and Well.	Well.	Well.	Well, Canal, and Town Supply.	Well.	Well.
	gr.	gr.	gr.	gr.	gr.	gr.
Total Saline Matter ..	15·68	64·00	58·24	25·60	24·96	10·24
Total Organic Matter ..	3·20	7·04	9·28	12·16	6·72	6·08
Total Solid Matter ..	18·88	71·04	67·52	37·76	31·68	16·32
Chlorine	2·5	24·8	7·0	3·75	2·75	1·7
Calcic Carbonate	13·18	21;04	43·66	14·36	7·14	2·44
Calcic Sulphate	1·03	19·21	8·24	7·12	9·23	6·31

Table C.—Waters obtained from Pits.

—	Pits.	Quarry.	Pits.	Pit and Surface.	Pits.	Pits and Burn.
	gr.	gr.	gr.	gr.	gr.	gr.
Total Saline Matter ..	24·08	10·88	20·48	31·68	35·64	50·88
Total Organic Matter ..	2·88	6·08	3·20	4·28	11·20	9·28
Total Solid Matter ..	26·96	16·96	23·68	35·96	46·84	60·16
Chlorine	1·5	2·75	2·0	1·3	2·0	2·0
Calcic Carbonate	18·21	3·42	8·43	12·26	18·56	12·27
Calcic Sulphate	4·31	4·06	6·54	14·33	12·21	20·54

Table D.—Sewage-Impregnated Waters.

—	Burn.	Burn.	Loch.
	gr.	gr.	gr.
Total Saline Matter	15·36	26·56	15·68
Total Organic Matter..	6·40	6·72	6·40
Total Solid Matter	21·76	32·28	22·08
Chlorine	3·7	7·0	5·0
Calcic Carbonate..	6·16	5·61	12·21
Calcic Sulphate	16·00	16·32	0·34

with soda salts in solution, and are not advisable for boiler supply. At the same time it should be mentioned that such waters are in much repute with practical engineers, on account of their scouring properties, and it is by no means uncommon where these waters can be obtained to regularly employ them for cleaning purposes. Were the use of the waters restricted in this way, little damage might accrue, but their systematic employment should not be allowed, on account of the deleterious effect of the oily constituents.

Pit waters and surface waters are liable to contain matter in suspension, and this increases very greatly the difficulties of dealing with the water. Waters derived from coal-pits, and containing coal-dust in minute portions, or those obtained from shale pits, and having suspended sharp clean particles of shale, can be used with advantage, if not acid; but waters containing earthy impurities or suspended chalk should not be employed. The presence of coal and shale dust in water tends to give a scale or deposit much less hard in structure than would otherwise be the case, and may sometimes even cause the incrustation to become a loose mud.

Surface waters from the neighbourhood of chemical works, especially those where sulphuric, sulphurous, or hydrochloric acids are made or evolved, as in alkali, manure, and paraffin works, or in the vicinity of burning bings of ironstone or blaes, generally contain much free acid in solution, and are most injurious as feed waters. The drainings from blaes or coal slacks and from shale refuse contain acid sulphates of iron and alumina, and should not be employed. The same remark applies to burnt or unburnt sulphur ore (iron pyrites), or copper pyrites.

Moss waters, or waters derived from sources where peat abounds, are of first-class quality for boiler purposes. These waters almost invariably contain a small quantity of saline matter in solution, and what little deposit is formed is in the condition of a mud, much mixed with organic vegetable matter, and readily removed by the blow-off cock.

The composition of the incrustation left by these waters is given in Tables E and F; they will be seen to divide themselves into a carbonate class and a sulphate class, the latter being much the more common of the two.

Table E.—Boiler Incrustations.—Carbonate Class.
No Anti-incrustator used.

—	Well.	River.	Spring.	Well and Town Supply.	River.
Ferric Oxide (Fe_2O_3) Aluminic Oxide (Al_2O_3)	7·46	2·96	2·36	2·48	2·96
Calcic Carbonate ($CaCO_3$)	32·16	74·25	50·04	62·95	75·92
Calcic Sulphate ($CaSO_4$)	5·64	3·08	29·76	20·80	3·16
Magnesic Carbonate ($MgCO_3$)	20·04	3·76	10·84	7·24	10·16
Sodic Salts, &c.	3·31	1·15	0·86	0·86	0·84
Silica (SiO_2)	16·94	8·56	4·28	3·76	4·94
Organic Matter	7·70	3·02	0·48	0·12	0·22
Moisture	6·78	3·10	1·22	1·22	1·53
Total	100·05	99·88	99·84	99·43	99·73

Table F.—Boiler Incrustations.—Sulphate Class.
No Anti-incrustator used.

—	Pits and Surface Water.	Quarry and Salt Water.	Quarry.	Pits and Surface Water.	Well.	Burn.	
Ferric Oxide (Fe_2O_3) Aluminic Oxide (Al_2O_3)	4·64	3·56	2·88	2·92	5·04	1·68	4·06
Calcic Carbonate ($CaCO_3$)	1·22	26·56	17·31	16·45	25·62	0·72	1·21
Magnesic Carbonate ($MgCO_3$)	10·36	23·16	18·04	17·32	5·56	18·40	5·60
Calcic Sulphate ($CaSO_4$)	78·32	38·16	53·76	39·28	55·92	56·28	50·36
Sodic Salts, &c.	0·64	1·75	0·54	0·86	0·22	0·56	0·21
Silica (SiO_2)	3·22	5·42	4·36	21·62	5·26	9·46	36·22
Organic Matter	0·56	0·12	0·33	0·17	0·36	2·64	0·68
Moisture	0·72	1·04	0·78	1·18	1·34	1·67	1·88
Total	99·68	99·77	100·02	99·80	100·30	100·41	100·22

Carbonate scales are usually more brittle than sulphate deposits, which tend to toughness in fracture. The carbonate deposits occasionally appear as a pulverulent mass somewhat resembling chalk in consistence. Very much depends on the method of reducing the firing before cleaning. If the fire be drawn and the water run off whilst the flues are hot, the deposit becomes dry and tough, and very difficult to remove. On the other hand, where the water is allowed to remain to cool slowly before any attempt is made to remove the deposit, the scale is more easily detached, and less chipping is necessary.

Pit waters are frequently acid in character, from the presence in solution of the sulphates of alumina and iron, derived from the oxidation of the pyrites present in the coal or shale. The scale or deposit left in the boiler always contains much iron as oxide, whilst the calcic carbonate is converted either totally or partially into sulphate. The analysis of a deposit from a boiler fed with acid pit water illustrates these changes;—

Table G.—Incrustation.—Acid Pit Water Used.

Calcic Carbonate	23·46
Calcic Sulphate ..	36·28
Ferric Oxide	27·88
Magnesic Carbonate	2·78
Insoluble matter ..	5·64
Moisture	3·96
	100·00

In the above incrustation, the acidity of the feed water was overcome by the addition of extra fresh water containing calcium carbonate, so that the ferric oxide must have been present in the feed water. Had no extra water been used, or had such been of a permanently hard nature, much damage must have been done to the boiler plates by the employment of this water.

Sea water, especially when heated, has much action on iron and other metals. This is due more especially to the decomposition of the chloride of magnesia contained in the water. An analysis of the incrustation formed on the salt-water pipes supplying hot water to a large hydropathic establishment will illustrate the composition of such deposits:—

Table H.—Deposit from Salt-water Pipes.

Calcic Carbonate	2·20
Ferric Oxide	83·80
Magnesic Carbonate ..	—
Insoluble Matter	5·28
Organic Matter .. } Moisture .. .. .. }	
	100·00

Macadam finds it impossible to consider even a large proportion of the many and various substances from time to time introduced to prevent or destroy boiler scale or incrustation. Very many of the patents are absolutely worthless, some decidedly hurtful or dangerous. He throws the more common bodies into classes, and offers the following notes on their properties, dividing the subject under two heads: The first and more crude method being the employment of an anti-incrustator placed inside the boiler; whilst the second takes in the various methods of softening and removing deleterious substances before the water is admitted into the heating chamber. Some of the anti-incrustators profess to remove scale by chemical means—in other words, to dissolve the hard calcareous deposit. These substances are not in general favour, and rightly so, as it is found that the regular employment of such bodies causes much damage to boiler plates and to the brass and gun-metal fittings of the cylinders. The larger number of anti-incrustators profess to prevent the formation of a scale rather than its removal, and although, after a time, they may cause the previously-formed scale to break up and be easily removed, yet such is traceable as much to mechanical means as to chemical action. The probable explanation is that the iron plates being more readily expanded on the application of heat, or more readily cooled on the withdrawal of the fire, cause unequal expansion in the incrustation, and consequent fissuring. The cracks, from the presence of a preventive anti-incrustator, are not repaired, and so in course of time the old scale is broken up and removed from the boiler.

The anti-incrustators can be considered in the following classes: (1) Saline; (2) Fats and Oils; (3) Paraffin and Paraffin Products; (4) Other Organic Substances (including the gelatinous group).

Saline Anti-Incrustators.—The most common substance in this class is soda ash, or the more pure soda crystals. These two substances are regularly sold at very large profits to manufacturers, and receive very many names in the trade. One sample, commonly and extensively in use in and about London, consists simply of soda crystals roughly coated with litmus powder, and yet this simple addition gives a profit to the maker enormously greater than could possibly be obtained for the body if sold for what it in reality is. The action of this substance depends on the interchange of acids with the calcium sulphate, yielding a proportion of sulphate of soda, which principally remains in solution and passes off by the blowcock, but is also found in varying proportions in the incrustation, The scale formed where soda crystals are used is frequently very hard, and difficult to remove. The chemical composition of this class of incrustation is given in Table I.

Table I.—Boiler Incrustations.—Carbonate of Soda used in Boiler.

—	Well.	Town Supply.	Well.
Ferric Oxide (Fe_2O_3) .. .. Aluminic Oxide (Al_2O_3)	1·96	9·84	3·44
Calcic Carbonate ($CaCO_3$)	34·67	63·64	9·52
Magnesic Carbonate ($MgCO_3$)	23·84	5·32	19·88
Calcic Sulphate ($CaSO_4$)	25·88	1·44	48·20
Sodic Sulphate, &c. (Na_2SO_4)	6·41	4·45	10·02
Silica (SiO_2)	5·54	10·34	5·36
Organic Matter	0·25	1·09	0·32
Moisture	1·34	2·53	3·06
Total	99·89	99·65	99·80

Acids and mixtures intended to liberate such, as oil of vitriol and common salt (G. E. Davis, in papers read before the Manchester Scientific and Mechanical Soc., 1879, p. 36), should never be employed, on account of the solvent action they have on iron, brass, &c. Barium chloride forms the insoluble sulphate of barium, which, sinking to the bottom of the boiler, adds greatly to the scale. Davis, in the paper above quoted, recommends "tripsa" (the tribasic sodic phosphate), and states that he has obtained good results from its use. He, however, does not state the cost, nor does he make any mention of the commercial value of the by-products, which might be useful in manure manufacture, if obtainable in quantity.

Sulphites are occasionally employed. Morgan's compound belongs to this class. As far as Macadam can learn, they act well with salt water, giving a soft sludge, which should be readily removed by the blowcock. He analysed the sediment from the boiler of a steam-tug which had been using Morgan's solution for about 10 days. The results gave an indication of the action of the compound. The boiler had been in work for a week without any anti-incrustator, and a certain amount of hard scale had been formed, an analysis of which is also given :—

Table J.—(*a*) Boiler Incrustation.—Sea Water.

Calcic Carbonate	42·55
Calcic Sulphate	35·99
Ferric Oxide	3·62
Magnesic Carbonate ..	4·28
Magnesic Chloride	0·24
Soda Salts, &c.	0·64
Organic Matter	3·19
Moisture	1·68
Insoluble Matter	7·81
	100·00

(*b*) Sediment from Boiler.
Sulphite Anti-Incrustator.—Sea Water.

Calcic Sulphate	75·61
Ferric Oxide	0·92
Magnesic Sulphate	2·19
Magnesic Chloride	1·38
Soda Salts	5·48
Organic Matter	6·02
Moisture	7·78
Insoluble Matter	0·62
	100·00

Fatty Anti-Incrustators.—Tallow is most usually employed, but the coarser and low class oils also occasionally find their way into the market. These substances cannot be too strongly condemned, as they are without doubt most hurtful. The oil or fat, at the temperature to which it is exposed, is partly split up into fatty acids, which act upon the sides of the boiler or on brass fittings, and partly combines with the lime present in the feed water, forming a lime soap, which, becoming attached to the plates, is burned, yielding a tough mass or scale, and causing very great loss of heat from its non-conductive power. The analyses given in Table K show the presence of a very large proportion of iron, and as neither water supply contained appreciable quantities, we are compelled to go to the boiler plates as the source. That tallow should continue in use seems extraordinary, as it is a well-known fact amongst practical engineers that any little good that may be done by tallow on stray occasions, as on entering a muddy river from the sea, when a small quantity is said to be advisable, is far over-balanced by the damage sustained by the boiler plates. The engineers of our largest railway companies and steamship lines unite in condemning the use of tallow in boilers; they even state that before a new locomotive or stationary boiler can be used without priming, steam must be raised in it several times, and the water afterwards blown out, so as to get rid of the oil used in boring the rivet holes, and that

Table K.—Boiler Incrustations—Tallow employed.

——	Loch.	River.
Ferric Oxide (Fe_2O_3) .. .. Aluminic Oxide (Al_2O_3)	11·60	25·72
Calcic Carbonate ($CaCO_3$)	5·92	44·83
Magnesic Carbonate ($MgCO_3$)	6·76	6·44
Calcic Sulphate ($CaSO_4$)	1·52	3·12
Sodic Salts, &c.	trace	0·44
Silica (SiO_2)	12·16	13·33
*Organic Matter	58·50	3·80
Moisture	3·64	2·24
Total	100·10	99·92
*Oily Matter	57·47	3·20

soda may even be necessary before this can be accomplished.

Much controversy has of late arisen as to the presence of oily or fatty substances in "scales" and "feed waters." Macadam generally found considerable quantities in deposits derived from boilers where tallow was used, but it is most abundant on the inner surface of the crust and farthest from the fire.

No member of this series should be used in or about steam boilers, for even where employed as lubricants, they pass into the feed waters and cause much damage and annoyance. The analysis of a sediment from a condensed-steam tank, where tallow was used as a lubricant, illustrates the very large amount of oil which can find its way into feed waters from such sources:—

Table L.—Sediment from Condensed-Steam Tank.

Tallow used as a lubricant.

Ferric Oxide (Fe_2O_3) ..	50·21
Aluminic Oxide, &c. (Al_2O_3)	1·07
Calcic Carbonate ($CaCO_3$)	0·31
Magnesic Carbonate ($MgCO_3$)	1·28
Calcic Sulphate ($CaSO_4$) ..	1·43
Cupric Oxide (CuO) ..	0·88
Sodic Salts, &c.	0·11
Silica (SiO_2)	1·38
*Organic Matter	41·93
Moisture	0·87
Total ..	100·47
*Oily Matter	41·36

The copper present was undoubtedly derived from the fittings, and along with the ferric oxide shows very well the action of the fatty acids on the metals.

Paraffin and Paraffin Products.—Paraffin oil, when introduced into boilers, causes the deposit thrown down by the water to take the form of a soft mass of rounded particles, easily removable by the frequent use of the blowcock. It is evidently purely mechanical in its action, for the deposit shows on analysis a composition similar to that obtained by the evaporation of the water, whilst the oil can be detected and separated from the mass. The large amount of calcium carbonate shows how little change has taken place. In the table of analyses given under this section, it will be observed that in one case the proportion of iron oxide is very large, but this was traced to the employment of tallow along with the paraffin oil. After the animal fat had been stopped for some time, a new analysis gave the percentage of iron at a very much lower figure, and it has since gradually fallen to a normal amount. Paraffin oil soaks into scale which may have been previously formed in the boiler, causing it to split up and be easily removed. The difficulty as to the employment of this oil seems to be that its searching action is so great as to cause the thorough cleansing of the plates and consequent leakage at faulty joints. Its use is unattended by priming, and the amount of the oil may be increased without fear from this source. It is found necessary first to introduce the oil when the boiler is empty, but further supplies can be afterwards added without this precaution. The employment of condensed waters should be dispensed with where fatty oils are employed as lubricants, or paraffin may be substituted, and the use of the exhaust continued. Care must, however, be taken that the lubricating oil used be perfectly free from paraffin scale, otherwise the latter, finding its way into the cylinders, will form a hard cake very similar to that obtained when tallow is used. To the presence of paraffin scale may be attributed much of the feeling engineers have against paraffin lubricants. The heavier oils can readily be got free from the scale, and yet retain the viscosity so necessary for high-pressure engines, the lighter lubricating oils being perfectly suitable for low-pressure fittings. Several mixtures of paraffin oil with the fatty oils are to be obtained, but these have the same disadvantage as tallow, namely, the formation of a lime soap, which, however, is not so injurious in this case, from the presence of the paraffin oil.

The soda tar obtained during the purification of crude paraffin oil, and

Table M.—Boiler Incrustations.—Paraffin Oil employed.

—	Well.	Well.	Well.
Ferric Oxide (Fe_2O_3) .. .. Aluminic Oxide (Al_2O_3)	5·48	2·12	22·88
Calcic Carbonate ($CaCO_3$)	34·03	53·16	1·21
Magnesic Carbonate ($MgCO_3$)	29·16	20·03	3·08
Calcic Sulphate ($CaSO_4$)	4·04	10·52	50·88
Sodic Salts, &c.	0·26	0·56	0·36
Silica (SiO_2)	13·88	5·56	10·66
Organic Matter (including oil)	6·61	5·44	10·24
Moisture	5·48	2·03	0·58
Total	98·94	99·92	99·89

consisting partly of caustic soda and partly of carbonate, with a proportion of the tar acids from the crude shale oil, furnishes one well-known anti-incrustator. Its action is both chemical and mechanical, and the tar acids seem to have little deleterious action on the iron plates.

Table N.—Boiler Incrustation.—Paraffin Soda-liquor employed.

—	Town Supply, Rain Water, and Well.
Ferric Oxide (Fe_2O_3) .. Aluminic Oxide (Al_2O_3) ..	2·12
Calcic Carbonate ($CaCO_3$)	84·86
Magnesic Carbonate ($MgCO_3$)	1·76
Calcic Sulphate ($CaSO_4$) ..	3·52
Sodic Salts, &c...	1·37
Silica (SiO_2)	3·02
Organic Matter	1·26
Moisture	1·96
Total ..	99·97

Other Organic Compositions.—Peat or moss has been used in many cases with the best results, whilst with some waters potatoes act well. The residue in the boiler is soft, and the blowcock should be frequently used. Many other organic materials have from time to time been in the market. They form an important class of substances, and many of them give good results. The analyses of the incrustations show an increase in the proportion of organic matter, but otherwise they do not materially differ from those obtained from the same waters when no anti-incrustator is used.

These organic substances are frequently mixed with salts, and have then the properties of both classes—that is to say, chemical and mechanical actions. They are liable, however, when used with hard waters, to form somewhat dense cakes, which become more or less hard, are charred, and cause overheating and consequent damage. This seems to be due to an excess of the saline constituent, for natural substances containing little alkaline base in proportion to organic constituent do not seem to give similar results. The saline ingredient is generally caustic soda or soda ash.

In this class ranks Baudet's patent, which consists in adding to the water sodic thiosulphate dissolved in rain water, and mixed with glycerine. The advantages claimed by the patentee are a greater solubility for the calcic sulphate, whilst the phosphates and carbonates are precipitated and form a gelatinous mass with the glycerine. To the same series must also be added Bonneville's patent, which consists of baric carbonate, ammonic nitrate, common salt, and vegetable charcoal, a mixture which has the double advantages of being complex and somewhat costly

Table O.—Boiler Incrustations.—Organic Composition used.

—			Pits.	Well.	Pits.	Pits.	Pits.
Ferric Oxide (Fe_2O_3) .. .. Aluminic Oxide (Al_2O_3) ..	2·20	2·60	2·64	3·08	14·00	5·16	1·68
Calcic Carbonate ($CaCO_3$) ..	29·28	10 18	16·54	44·32	19·84	16·00	29·69
Magnesic Carbonate ($MgCO_3$)	6·11	7·46	22·84	20·76	16·44	25·60	37·32
Calcic Sulphate ($CaSO_4$) ..	53·53	71 35	28·08	11·16	30·03	18·28	22·32
Sodic Salts, &c.	0 54	0·32	1·23	0·41	0·36	0·92	1·31
Silica (SiO_2)	2·29	2 22	8·12	14·46	12·22	19·43	3·84
Organic Matter	3·37	4·14	14·04	2·26	8·03	11·13	2·65
Moisture	2·32	1·74	6·58	3·53	1·74	3·42	0·98
Total	99·64	100·01	100·07	99·98	99·76	99·94	99·79

Table P.—Boiler Incrustations.—Mixed Organic and Saline Composition used.

—		Spring, Surface and Well.	Sewage and Surface.	Sewage and Surface.	Canal.	Sewage, Burn.	Sewage.	Loch.	Canal.	Sewage.
Ferric Oxide (Fe_2O_3) .. .. Aluminic Oxide (Al_2O_3) ..	6·36	2·12	4·16	1·96	3·81	3·68	3·72	4·16	4·72	6·20
Calcic Carbonate ($CaCO_3$) ..	71·67	8·68	15·17	11·30	8·28	47·35	58·78	60·85	69·55	27·06
Magnesic Carbonate ($MgCO_3$)	11·08	15·40	11·08	7·76	13 96	6·42	6·84	19·44	11·92	10·88
Calcic Sulphate ($CaSO_4$) ..	8·56	59·60	55·96	66·16	65·48	33·10	16·24	6·33	4·80	36·16
Sodic Sulphate, &c.	0·62	3·14	4·46	5·67	0·56	0·36	3·11	1·17	1·22	0·14
Silica	1·24	3·65	7·30	2·24	6·23	6·43	6·61	5·66	5·24	15·88
Organic Matter..	0·86	0·86	2·23	2·37	0·80	0·58	1·60	0·26	0·31	2·06
Moisture	0·49	6·33	1·69	1·35	1·22	1·84	2·97	2·08	2·27	2·72
Total	99·88	99·78	99·95	99·87	100·43	99·76	99·97	99·88	100·03	100·10

with comparison to others of the same series. Substances containing tannin are not unfrequent, but as they are generally presented in a dry form, should be well soaked in water before being introduced into the boiler, else they are liable to be carried over mechanically with the steam, and give much annoyance by choking the pipes and valves. Care must be taken also where the steam is to be blown into tanks for heating purposes, as in flax and hemp boiling, the tannic acid forming with the iron present in the fibre a black stain or blot, which cannot be bleached without the use of an acid, and consequent liability to damage the tissue. Table Q gives the results of the analysis of a portion of scum obtained from a flax boiler, and it will be seen that the iron is present in considerable quantity.

Zinc has been employed in some cases, but has not been successful in boilers fed with fresh water, although with sea water it is said to be of use. The action seems to be one in which the zinc becomes a chloride. It is said that steamers whose boilers required at one time very frequent "chipping out" can now run considerable distances, with the frequent use of the blowcock.

Mechanical apparatus placed inside boilers has not proved successful, and electricity has given like results. The coating of boilers with copper is injurious, and zinc galvanizing is dissolved rapidly even with a fresh-water supply.

Table Q.—Analysis of Scum from Flax Boiler in which an Anti-Incrustator containing Tannin was used.

Moisture		32·52
Organic Vegetable Matter		20·44
Ferric Oxide	4·56	
Calcic Carbonate ..	18·04	
Magnesia and Magnesic Carbonate	8·34	
Potash Salts	2·12	
Silicious Matter	13·98	
Total Saline Matter	——	47·04
		100·00

Looking at the great loss of heat consequent on the formation of scale, it seems astonishing that so little has been done in softening water for steam raising. The loss of heat, in many cases, is enormous. George E. Davis mentions one instance where 17 per cent. of the whole disappeared, and this figure, large as it was, is much below the maximum loss. This loss of heat will be more readily appreciated when it is stated that ⅛ in. of scale represents the employment of 16 per cent. more fuel; ¼-in. scale equals 50 per cent. extra coal, and a ½-inch deposit means 150 per cent. of additional firing. Many engineers believe in the necessity of a certain amount of scale to tighten the joints and rivet heads, but it is an indisputable fact that the cleaner the plates the less the loss in fuel. When the water contains calcic carbonate in solution, heating it will generally suffice, and for this purpose mechanical heaters are useful. One ingenious patent consists in a small tank placed in the boiler (an egg end), with the exit tube taken from near the top. The apparatus is said to work well, but it is useless when calcic sulphate is present in the water, as that body does not become insoluble till heated under pressure to about 302° F. (150° C.). The following analysis will illustrate the action of these mechanical heaters. The boilers to be fed are multitubular, and much difficulty is experienced from deposit, the available water being hard in quality, and having much matter in suspension. This suspended matter varies considerably throughout the day.

Table R.—Mechanical Heaters.
Boiler Supply.

In 1 Imp. Gal. :—	Water before the Heaters.	Water after Heaters.
Saline Matter ..	28·42	28·68
Organic Matter ..	1·56	0·94
Total Solid Matter	29·98	29·62
Suspended Matter :—	Gr.	Gr.
Principally Organic	0·46	—
Precipitated Carbonate of Calcium	—	2·48
In Solution :—		
Calcic Carbonate ..	6·64	4·48
Calcic Sulphate ..	8·24	8·06

From these results it is seen that the calcic carbonate suspended in the water can be traced to the loss of calcic carbonate in solution. Little good, however, has been done, as the suspended matter is not taken out of the water before it passes to the boilers. After some improvement in the heaters, another analysis of the water gave better results.

Table S.—Mechanical Heaters.
Boiler Supply.

In 1 Imp. Gal. :—	Gr.
Saline Matter	15·84
Organic Matter	0·85
Total Solid Matter ..	16·72
In Suspension :—	
Calcic Carbonate	0·46
In Solution :—	
Calcic Carbonate	1·24
Calcic Sulphate	2·44
Soda Salts	Abundant.

It now appears that the calcic carbonate has decreased very much. This result was obtained by an increase of temperature consequent on the employment of steam direct from the boilers, in place of the waste steam from the cylinder, as previously utilized. At the same time sodic carbonate was introduced along with the feed water, which, acting on the calcic sulphate, caused double decomposition, with precipitation of calcic carbonate. The following analysis of the scale from the boilers before and after the employment of the heaters is interesting:—

Table T.—Incrustations from Boilers.
Heaters used.

	Before Heaters in use.	After Heaters in work. (No Soda.)
Calcic Carbonate	30·89	1·36
Calcic Sulphate ..	31·22	79·61
Ferric Oxide ..	2·96	1·12
Magnesic Carbonate	26·41	14·22
Soda Salts, &c. ..	0·48	0·46
Silica	4·54	2·15
Organic Matter ..	2·66	0·85
Moisture	0·84	0·23
	100·00	100·00

Thus the change in the composition of the water supply caused by the heaters is fully as well shown in the scale from the boilers. The calcic carbonate previously present in considerable quantity has almost disappeared. The magnesic carbonate is only about ½, whilst the ferric oxide, organic matter, and insoluble portion have been much diminished. Of course it must be remembered that this is not entirely due to the removal of the saline ingredients of the water supply, but is to a large extent traceable to the greatly increased supply of condensed water flowing from the heaters and sent to the boilers. This condensed water is much larger in proportion than would be the case in ordinary working, for it must be remembered that the heaters are being worked with steam direct from the boilers, instead of the waste cylinder supply. The sediment removed from the water by the heaters falls to the lower part of the apparatus, and is to some extent removed by a blowcock, which is to b used 4 times daily, but a larger amoun remains in the apparatus, and is washe out once a month. The analysis of thi sediment shows:—

Table U.—Sediment from Heaters.

Calcic Carbonate	2·77
Calcic Sulphate	0·61
Ferric Oxide	19·77
Ferrous Carbonate ..	2·54
Magnesic Carbonate ..	1·02
Soda Salts, &c.	0·46
Silica and Clay	47·34
Organic Matter	25·49
	100·00

These results show that whilst the calcic carbonate is removed by the blowcock, the heavier oxide of iron falls t the lower part of the apparatus alon with the sand and clay derived fron the dirty water supply. The analysi of the liquid from the blowcock give the following results:—

Table V.—Water from blowcock of Heaters.

In Suspension:—	Per gal.
Saline Matter	1·61
Organic Matter	0·45
Solid Matter	2·06
Calcic Carbonate	0·53
Calcic Sulphate	0·11
Ferric Oxide	0·28
Organic Matter	0·45
Insoluble Matter	0·51
Suspended Matter:—	Per cent.
Calcic Carbonate	25·72
Calcic Sulphate	5·34
Ferric Oxide	13·59
Organic Matter	21·84
Insoluble Matter	24·75
In Solution:—	Per gal.
Saline Matter	12·72
Organic Matter	2·96
Solid Matter	15·68
Calcic Carbonate	3·68
Calcic Sulphate	5·61

The simple heating of the feed water, *before passing into the boiler*, either by a direct fire or by the employment of waste steam, does good by removing much of the calcic carbonate, and settling out a considerable proportion of the suspended matter, whether such be of mineral or organic origin. As, however, the water is not under pressure, the calcic sulphate is practically undiminished in quantity. In one case, the waste steam is passed through copper pipes laid near the bottom of an iron cistern. The tank is 14 ft. long, 7 ft. deep, and 7 ft. broad, and has 24 pipes of 3 in. diameter laid within 6 in. of the bottom. Through these pipes the waste steam of a Lancashire boiler is passed, sufficient heat being obtained to raise 36,000 gal. water per week to a temperature ranging from 180° to 200° F. (82°–93° C.). The steam and water condensed are then blown into another tank, and so utilized. The results of the analysis of the water before and after the heating are given in Table W :—

Table W.—Boiler Feed-water heated in Tank by Waste Steam to a temperature of 180° to 200° F. per gal.

	Before Heating.		After Heating.
Saline Matter ..	52·02	..	43·84
Organic Matter ..	7·04	..	5·18
Total Solid Matter	59·06		49·02
Calcic Carbonate	20·64	..	9·92
Calcic Sulphate ..	11·36	..	12·24

These results show that the heating throws down a very considerable proportion of the calcic carbonate, the actual amount being 10·72 gr. per gal. of water, or a little over a half of the whole present. The result of the operation will be more fully appreciated if the amount is calculated per week or per year :—

Table X.—Calcic Carbonate removed from Boiler Feed-water by Waste-steam Heat.

Per gallon	10·72 gr.
Per week	55·1714 lb.
Per year	2868·9128 lb. (1·2807 ton).

Besides the calcic carbonate, a proportion of the organic matter is deposited, the amount being :—

Table Y.—Organic Matter removed from Boiler Feed-water by Waste-steam Heat.

Per gal.	1·58 gr.
Per week	8·1371 lb.
Per year	423·1292 lb.

These two ingredients added together give the following results :—

Table Z.—Calcic Carbonate and Organic Matter removed Yearly from Boiler Feed-water by Waste-steam Heat.

	lb.		ton.
Calcic Carbonate	2868·9128	=	1·2807
Organic Matter	423·1292	=	0·1889
. ..	3292·0420	=	1·4697

These figures do not represent the total matter removed, for they do not include magnesic carbonate, ferric oxide, nor a small proportion of calcic sulphate. The deposit formed is somewhat soft, but becomes very hard on drying. The analysis yielded the figures given below :—

Table AA.—Sediment from Water heated by Waste Steam.

Calcic Carbonate .	66·76
Calcic Sulphate .	2·37
Ferric Oxide .. .	3·41
Magnesic Carbonate	17·42
Soda Salts, &c... .	0·24
Silicious Matter .	0·52
Organic Matter .	6·84
Moisture	2·44
	100·00

The amount of saline ingredients removed from a water by heat depends greatly upon the actual temperature to which the water is raised. A series of experiments was made with a tank heated by a direct fire to a temperature of 130° F. (54½° C.). The results are :—

Table BB.—Boiler Feed-water heated to 130° F. by direct Fire.

	Water before Heating.		Water after Heating.
Saline Matter	33·44		28·56
Organic Matter	5·04		3·92
Solid Matter	38·48		32·48
Calcic Carbonate	11·85	..	7·52
Calcic Sulphate ..	7·82	..	8·56

Calculated to the gallon, week, and year, the following figures are obtained, 36,000 gal. water being heated per week:—

Table CC.—Calcic Carbonate removed by direct Heat (temperature of water, 130° F.).

Per gallon	4·33 gr.
Per week	22·2685 lb.
Per year	1157·962 lb.

Table DD.—Organic Matter removed by direct Heat (temperature of water, 130° F.).

Per gallon	1·12 gr.
Per week	5·96 lb.
Per year	309·92 lb.

Table EE.—Calcic Carbonate and Organic Matter removed per Year by direct Heat (temperature of water, 130° F.).

	lb.		ton.
Calcic Carbonate	1157·962	=	0·517
Organic Matter ..	309·92	=	0·138
Total	1467·882	=	0·655

The incrustation formed was hard and tough, and had the following composition:—

Table FF.—Incrustation of Water heated by direct Fire to a temperature of 130° F.

Calcic Carbonate	87·43
Calcic Sulphate	1·42
Ferric Oxide	2·68
Magnesic Carbonate	4·33
Soda Salts, &c.	0·32
Insoluble Matter	0·72
Organic Matter	1·56
Moisture	1·54
	100·00

Clarke's process, the addition of milk of lime, is suitable, but the space required for settling is against the general adoption of the method. This difficulty may, however, be got over by the employment of Porter's filtering cloth apparatus, with the careful adjustment of the quantity of milk of lime added. The process, however, is only of use in the case of temporary hard waters. Baron Nicolas de Derschau (Jl. Soc. Chem. Ind., No. 5, Vol. I., May 1882, p. 176) employs Porter's principle, using, however, magnesia instead of lime. This process can be employed with sulphate of lime waters, magnesia sulphate being produced, and from its solubility remaining in solution. De Haen's process, the addition of baric chloride, is (as mentioned by Davis in the paper previously quoted) both costly and somewhat doubtful of action, even where lime water is afterwards added. Davis's "tripsa" (tribasic phosphate of soda) deserves a fair trial as a softening agent. The addition *to the feed water* of caustic soda, or still better of soda ash, and at the same time raising the temperature by utilizing waste steam or heat, would be beneficial in most cases, care being taken to afterwards settle or filter the water. Soda ash was first recommended in the columns of the *Times* of March 17, 1864, by Peter Spence of the Manchester Alum Works, who says—"For every boiler, 2 lb. of soda ash (an article easily procured at 1¼*d.* per lb.) is every day given to the stoker; this he dissolves in a bucketful of cold water, and puts the solution into the water supply for the boilers; this he does as part of his imperative daily duties, and the consequence is that now not the slightest corrosive action takes place, an additional advantage being that no crust is ever formed in my boiler, all the lime salt that forms these crusts being also destroyed by the alkaline solution."

No attempt should be made to soften water or employ anti-incrustators without first making a searching inquiry as to the nature of the waters available and the scale they may form. No special law can be laid down for the softening of water or the use of anti-incrustators —the cause of the disease must first be learned, and then the remedy may be safe and sure. To limit the materials used, by laying down a hard and fast law, would be to cause injury and loss to the steam user. The best results are obtained by the employment of a man of skill, and the rigid working out of his suggestions.

The discussion which followed Macadam's paper elicited the following remarks. Deposits from waters containing both carbonate and sulphate of lime vary considerably, from a tough fibrous deposit very difficult to remove, to a light friable deposit that can almost be blown out of the boiler; but nothing appears yet to be known about the proportions of carbonate and sulphate which are most favourable. Some years ago Ekin went into the question of water supply for the Somerset and Dorset Railway, as it was found that, with their *steep gradient over the Mendips*, the water they took from the Avon furred the boilers so quickly as to occasion great loss. He selected a different watering station with the best results, but, chemically speaking, there was very little difference between the objectionable and the good water, the permanent and total hardness being nearly the same in both. In this case the hard deposit from the Avon water may have been caused, in part, by the large quantity of sewage the river contained at the point from which the boiler supply was taken. B. E. R. Newlands observed that he was able to effect the removal of matters likely to cause incrustation, before the entry of the water into the boiler, with many thousands of gallons of river water a day, at the cost of about 1*d*. per 1000 gal., by an adaptation of the Porter-Clarke process. While there are undeniable advantages in water heaters, yet there was usually not even partially effective deposition of the separated matters before entering the boiler, without the use of a specially-constructed filter press. The same remark applies to the results of the use of "tripsa." The lime phosphate might be utilized if the boiler were regularly blown out, and no doubt a suitable filter-press could easily be constructed to meet the peculiarities of the case. The purification of water for steam-raising purposes is much to be preferred to the employment of anti-incrustators placed inside the boiler; but of course, such processes cannot always be used, from want of space, or on ships. Whilst the Porter-Clarke process only removes from solution the calcic carbonate and magnesic carbonate from water with any small proportion of iron salt present, yet each deposit, on falling down, encloses the suspended matters, whether of organic or mineral origin, and thus causes their removal. A reference to the results of the analyses of the waters from the mechanical heaters, and from the other heated-water supplies, shows this conclusively. In mechanical heaters, the tubes, doubtless by the constant currents of water, remain clean for a long time, while the sides become coated *with a deposit, which should not* be removed, as its non-conductivity retains heat. Mechanical heaters, to be of the greatest use, require to have some filtering apparatus attached, to eliminate the precipitated calcium and magnesium carbonates; this would entail a loss of heat, and thus greatly reduce the utility of the heaters. With paraffin lubricants as anti-incrustators, the condensed steam can be used without damaging the plates or fittings, but would not be suited for blowing into water used for dyeing boiling fibres, &c.

(See also 'Workshop Receipts,' an Spons' 'Dictionary of Engineering.')

CEMENTS AND LUTES.— The term "cement" is here used t denote only adhesive substances or com pounds, and does not include buildin cement; lutes are bodies employed t make tight joints without really effecting a tenacious union between the parts

A very comprehensive and valuabl account of cements is given in a littl work by John Phin, on the 'Preparation and use of Cements and Glue, published by the Industrial Publicatio Co., New York. This has formed th basis of the present article, to whic are added more recent recipes from the various technical journals, and other sources.

Phin has called attention to the fact that the success of a cement depends quite as much upon the manner in which it is used as upon the cement itself. It is especially necessary to understand the characters and properties of the cement. Every cement may be assigned to one of four classes, according as it (1), Dries by evaporation; (2), Congeals by cooling; (3), Hardens by oxidation; or (4), "Sets" by chemical changes. To the first class belong pastes, mucilages, alcoholic and other solutions of gums and resins, and, to a certain extent, glue. To the second belong such cements as sealing-wax, turner's cement, shellac, &c. The third class includes gold size, drying oil, white and red lead, &c.; and the fourth class covers plaster-of-Paris, the so-called iron cement, and others of that kind.

If the best results would be attained, the following rules must be rigorously adhered to:—

1. The cement must be brought into intimate contact with the surface to be united. Thus, when glue is employed, the surface should be made so warm that the melted glue will not be chilled before it has time to effect a thorough adhesion; a drop of melted glue allowed to simply fall on a surface of dry, cold wood and solidify there, will often fail to adhere at all, while if the same drop had been rubbed in, it would have attached itself to it with wonderful power of adhesion. The same is more eminently true in regard to cements that are used in a fused state, such as mixtures of resin, shellac, and similar materials. These matters will not adhere to any substance unless the latter has been heated to nearly or quite the fusing-point of the cement used. This fact was quite familiar to those who used sealing-wax in the old days of seals. When the seal was used rapidly, so as to become heated, the sealing-wax stuck to it with a firmness that was annoying, so much so that the impression was in general destroyed, from the simple fact that the sealing-wax would rather part in its own substance than at the point of adhesion to the stamp. Sealing-wax, or ordinary electrical cement, is a very good agent for uniting metal to glass or stone, providing the masses to be united are made so hot as to fuse the cement, but if the cement be applied to them while they are cold, it will not stick at all. This fact is well known to the itinerant vendors of cement for uniting earthenware. By heating two pieces of delf so that they will fuse shellac, they are able to smear them with a little of this gum, and join them so that they will break at any other part rather than along the line of union. But although people constantly see the operation performed, and buy liberally of the cement, it will be found that in nine cases out of ten the cement proves worthless in the hands of the purchasers, simply because they do not know how to use it. They are afraid to heat a delicate glass or porcelain vessel to a sufficient degree, and they are apt to use too much of the material, and the result is a failure.

The great obstacles to the absolute contact of any two surfaces are air and dirt. The former is universally present, the latter is due to accident or carelessness. All surfaces are covered with a thin adhering layer of air, which is difficult to remove, and which, although it may at first sight seem improbable, bears to the outer surface of most bodies a relation different from that maintained by the air a few lines away, and until this layer or film of air has been removed, it prevents the absolute contact of any other substance. The reality of the existence of this adhering layer is well known to all who are familiar with electrotype manipulation, and it is also seen in the case of highly polished metals, which may be immersed in water without becoming wet. Thus the surface of a needle retains this film of air so strongly, that it will float on the surface of water rather than give it up.

Unless this adhering layer of air is

displaced, it will be impossible for any cement to adhere to the surface to which it is applied, simply because it cannot come into contact with it.

The most efficient agents in displacing this air are heat and pressure. Metals warmed to a point a little above 200° F. (93½° C.), become instantly and completely wet when immersed in water. Hence for cements that are used in a fused condition, heat is the most efficient means of bringing them into contact with the surfaces to which they are to be applied.

When it is intended to unite two pieces of earthenware or glass together, or a piece of glass or other substance to metal, by means of a cement that is to be used in a fused state, the surfaces that are to be united should always be made so hot that the cement will become perfectly liquid when brought into contact with them.

In the case of glue, the adhesion is best attained by pressure and friction, combined with moderate warmth. In large establishments, where good glue joints are an important item, a special room, carefully warmed, is set aside for this operation.

2. A very important point is that as little cement as possible should be used. When the united surfaces are separated by a large mass of cement, everything depends upon the strength of the cement itself, and not upon its adhesion to the surfaces which it is used to join; and, in general, cements are comparatively brittle. At first sight one would suppose that the more cement is used, the stronger will be the joint, and this is an error into which most inexperienced persons fall. Two pieces of earthenware, joined together by a layer of shellac as thin as possible, will adhere together and will be as strong at the junction as at any other part, while the same pieces united by means of a layer of the same cement $\frac{1}{8}$ in. thick, would fall apart on receiving the slightest jar. The rule which directs us to use as little cement as possible, admits of no exceptions, and as a general thing the only way to obtain thin layers of cements that are to be used in a fused state, is to heat thoroughly the pieces that are to be united, press them forcibly together, and keep them under pressure by means of weights, screws, or cords until the cement has hardened.

3. The third point is the necessity for cleanliness, both in the preparation and in the application of the cements. It may be safely laid down as a positive rule that every extraneous substance that is mixed with the material of a cement is an injury to it. Glue prepared in a greasy pot cannot be expected to make a strong joint, and the presence of dust and dirt tends to weaken *all* cements. So, too, in the application of cements. If it be attempted to glue together two surfaces of wood that are covered with dirt, the substances that are to be united are not wood to wood, but dirt to dirt, and the joint, instead of possessing the strength of wood, united by means of good glue, will have simply the strength of dirt. Moreover, it must be remembered that the different cements do not adhere with equal force to substances of different kinds. Thus, glue adheres powerfully to wood and paper, but not at all to metal or glass. Shellac, if properly applied, adheres readily to earthenware, glass, and metal, but not to some other substances. If, then, glue be applied to a greasy surface, it will not stick. Hence the necessity for great cleanliness. All surfaces should be kept as clean as possible, or, if they should get accidentally soiled, they should be carefully cleaned. The mere rubbing of two wooden surfaces with a dirty hand will weaken the subsequent glue joint by at least 10 per cent.

The most common case in which this rule is violated by the inexperienced is in mending articles which have been formerly glued, and have been again broken at the old place. Such articles when first mended, frequently last for a long time, but when a second attempt is made to glue the pieces together, the joint seems almost to fall to pieces of itself. Here it is attempted to glue together, not two pieces of wood, but two pieces of old glue, and the result is failure. Soak off all the old glue (do not cut or scrape it, or the pieces will no longer fit accurately together), wash the surfaces with a sponge dipped in boiling water, and when they are dry and warm, glue them together in the usual manner, and you will be surprised at the strength of the joint.

4. See that the opposing surfaces make a close, neat joint, before you attempt to cement them. Two pieces of wood that are to be glued together should be planed up so true that they are in contact at every point, and where an article has been broken, the surfaces to be joined should be preserved from being broken or battered. This is particularly the case when articles of glass or earthenware are accidentally broken, and it is not convenient to mend them at the instant. They should be carefully wrapped up in separate pieces of paper, and laid away where they will not be soiled, and where the edges will not be chipped. In such cases the joint will be greatly disfigured, and considerably weakened if the edges are chipped and broken by careless handling, or by being needlessly and frequently fitted together. Keep the pieces from contact with each other and with foreign substances until you are ready to join them, and the joint will then be not only strong, but almost invisible.

5. Plenty of time should be allowed for the cement to dry or harden, and this is particularly the case with *oil* cements, such as copal varnish, boiled oil, white lead, &c. These cements are said to *dry*, but they do not dry by evaporation. Instead of losing anything, they actually gain in weight by absorbing oxygen from the air, and this process of oxidation is a very slow one, except as regards the very thin layer that is in immediate contact with the air. Thus when two surfaces, each ½ in. across, are joined by means of a layer of white lead placed between them, 6 months may elapse before the cement in the middle of the joint has become hard. In such cases, a few days or weeks are of no account; at the end of a month, the joint will be weak and easily separated, while at the end of 2 or 3 years it may be so firm that the material will part anywhere else than at the joint. Hence, where the article is to be used immediately, the only safe cements are those which are liquefied by heat and which become hard when cold. A joint made with marine glue is firm an hour after it has been made. Next, in rapidity of hardening, to cements that are liquefied by heat, are those which consist of substances dissolved in water or alcohol. A glue joint sets firmly in 24 hours; a joint made with shellac varnish becomes dry in 2 or 3 days. Oil cements (boiled oil, white lead, red lead, &c.) take months.

6. Where neatness as well as strength is an object, it will often be advisable to use a cement of a colour as nearly like that of the materials to be united as possible. Thus a white porcelain cup, mended with black cement, would show some very ugly lines. If, however, a white cement be used, the lines of fracture will be invisible. The same rule applies to other articles, and it is always easy to colour a cement to any desired tint. (Phin.)

Acid-proof.—(1) A solution of indiarubber in twice its weight of raw linseed oil, heated, and mixed with an equal weight of pipeclay, yields a plastic mass which will long remain soft under cover, and never completely hardens, so that it may be easily removed at pleasure. It resists most acids, and bears the heat at which sulphuric acid boils. (2) Melted indiarubber alone answers well for securing joints against chlorine and some acid vapours. (3) A mixture of Chinaclay and boiled linseed oil, in the proportions needed to produce the right consistence. (4) Quicklime and linseed oil, mixed stiffly together, form a hard cement, resisting both heat and acids. (5) A stiffly mixed paste of pipeclay and coal tar. (6) A cement which, according to Dr. Wagner, is proof against even boiling acids, may be made by a composition of indiarubber, tallow, lime, and red lead. The indiarubber must first be melted by a gentle heat, and then 6 to 8 per cent. by weight of tallow is added to the mixture while it is kept well stirred; next dry slaked lime is applied, until the fluid mass assumes a consistence similar to that of soft paste; lastly, 20 per cent. of red lead is added, in order to make it harden and dry. (7) A concentrated solution of silicate of soda, formed into a paste with powdered glass. (8) 1 part rosin, 1 sulphur, 2 brickdust; the whole is melted after careful mixing. This lute is proof against the attacks of nitric and hydrochloric acid vapours.

Alabaster.—Cements for uniting pieces of alabaster, marble, Derbyshire spar, and other kinds of white stone, are in frequent demand. The following recipes give satisfactory results. Those containing resin must be applied hot, and the pieces to be joined must also be heated up to the melting-point of resin. (1) Plaster-of-Paris made to a cream with water. Sets in a few minutes, but it does not become perfectly hard for several days, or until it is thoroughly dry. (2) Yellow resin, 2 parts; melt and stir in 1 part of plaster-of-Paris, which has been thoroughly dried and heated. (3) Yellow resin, beeswax and plaster-of-Paris, equal parts. (4) Resin, 8 parts; wax, 1; melt and stir in 4 of plaster-of-Paris.

Algerian.—This lute is composed of 2 parts wood ashes, 3 lime, 1 sand, mixed, passed through a sieve, moistened with water and oil, and beaten up with a wooden mallet till the compound has acquired the right consistence.

Almond paste.—(1) Ground almond cake, from which the oil has been expressed, is mixed up with an equal weight of whiting, and made into a stiff paste with water. It soon becomes very hard and tough. It is much employed for luting stills, retorts, &c., when the heat does not exceed about 320° F. (160° C.); it is capable of resisting the fumes of volatile oils, spirits, weak acids, &c., for some time, (2) Ground almond cake as (1), or linseed cake, is added to starch paste and gum-water.

Amber—(1) 2 surfaces of amber may be united by smearing them with boiled linseed oil, pressing them strongly together, and heating them over a clear charcoal fire. To keep the parts in firm contact, it may be well to tie them with the soft iron wire, known as binding wire. (2) A solution of hard copal in pure ether, of the consistency of castor oil, is suggested by Ph. Rust for cementing amber. The carefully-cleaned surfaces of fracture, coated with the solution, should be pressed together, and retained in contact by means of a string wound around the object, or in some other suitable way. The operation should be performed as rapidly as possible, since the evaporation of the ether impairs the adhesiveness of the cement; so that all arrangements for compressing the object should be made before laying on the cement. A few days are required for the complete hardening of it. In repairing tubes, as for pipes, any of the solution happening to pass into the interior should be carefully removed at once with a slender feather. (3) The *Canadian Pharmaceutical Journal* states that amber may be cemented by moistening the surfaces with solution of potash, and pressing them together.

Aquarium.—This term has been applied to various waterproof cements which have been used for joining the sides, ends, &c., of tanks for holding water for various purposes. The following are some of the best. (1) Take of finely powdered litharge, fine, white, dry sand, and plaster-of-Paris, each 3 parts, by measure; finely pulverized resin, 1 part. Mix thoroughly and make into a paste with boiled linseed oil to which dryer has been added. Beat the mixture well, and let it stand 4 or 5 hours before using it. After it has stood for 15 hours, however, it loses its strength. When well made, of good materials, this cement will unite glass and iron so firmly that the glass will often split in its own substance, rather than part from the cement. Glass cemented into its frame with this cement is good for either salt or fresh water. It has been used at the Zoological Gardens, London, with great success. It might be useful for stopping leaks in roofs and other situations. (2) This highly recommended cement is made by melting together, in an iron pan, 2 parts common pitch and 1 part guttapercha, and stirring them well together until thoroughly incorporated, and then pouring the liquid into cold water. When cold, it is black, solid, and elastic; but it softens with heat, and may be used as a soft paste, or in the liquid state, as is most suitable. It does not harden and crack, and answers an excellent purpose in cementing metal, glass, porcelain, ivory, &c. It may be used instead of putty for glazing windows. (3) Red lead, 3 parts; litharge, 1 part; made into a paste or putty with raw linseed oil. (4) A cement which gradually hardens to a strong consistence may be made by mixing 20 parts of clean river sand, 2 of litharge, and 1 of quicklime, into a thin putty with linseed oil. When this cement is applied to mend broken pieces of stone, as steps of stairs, it acquires, after some time, a stony hardness, and unites the parts with great firmness. (5) It is said that a cement of great adhesiveness may be made by mixing 6 parts of powdered graphite with 3 of slaked lime, 8 of sulphate of baryta, and 7 of linseed oil varnish. The mixture must be stirred to uniform consistency. (6) ½ lb. best white lead, ground in oil; ½ lb. red lead, dry; ½ lb. litharge, dry; the two last kneaded into the first. You have now 1½ lb. of the best putty for resisting water. It will soon become hard and continue so. The glass should be bedded in it, and when neatly finished, put away for a fortnight; then varnish with shellac, dissolved in methylated spirits—say, 1½ oz. to half a gill—put into a bottle and shaken, will be ready in an hour. It may be coloured, if need be, with a little vermilion. One coat, wherever there is any putty or metal exposed, will be sufficient, and will dry in a few minutes. Your tank will never leak after this if the frame and glass are strong. (7) Mix boiled linseed oil, litharge, red and white lead together, using white lead in the largest proportion, spread on flannel, and place on the joints. (8) A solution of 8 oz. glue to 1 oz. of Venice turpentine; boil together, agitating all the time, until the mixture becomes as complete as possible; the joints to be cemented to be kept together for 48 hours if required. (9) Take ½ gill of gold size, 2 gills of red lead, 1½ gill of litharge, and sufficient silver sand to make it a thick paste for use. This mixture sets in about two days. (10) Stockholm tar and red lead dries quickly and hard, after having been mixed to the consistency of butter. Good for almost anything except where great heat is used. (11) Zinc white 2 parts, copal varnish 1 part. (12) Common resin 8 parts, calcined plaster 1 part. Melt and incorporate. Add boiled oil 1 part. Apply warm.

Architectural.—Architectural cement is a kind of papier-maché, and is used for making entire models, busts, ornaments, &c., rather than for uniting the parts of any article. It is very light, and takes a good polish, but is easily affected by moisture. (1) Reduce paper to a smooth pulp by boiling it in water, and work it over. Squeeze this paste dry, and add an equal bulk of whiting. Then mix the whole into a paste of the required consistence with good size or solution of glue. (2) Same as (1), but with plaster-of-Paris instead of whiting. (3) Strong rice-water size is mixed with paper which has been pulped in boiling water; whiting is then added, in sufficient quantity to produce the desired consistence.

Armenian or Diamond.—(1) The jewellers of Turkey, who are mostly Armenians, have a singular method of ornamenting watch cases, &c., with diamonds and other precious stones, by simply gluing or cementing them on. The stone is set in gold or silver, and the lower part of the metal made flat, or to correspond with that part to which it is to be fixed. It is then warmed gently and the glue applied, which is so very strong that the parts thus cemented never separate. For this glue, which will firmly unite bits of glass and even polished steel, and which may, of course, be applied to a vast variety of useful purposes, a large number of formulæ have been published. The following is the original recipe:—Dissolve 5 or 6 bits of gum mastic, each the size of a large pea, in as much alcohol as will suffice to render them liquid; in another vessel dissolve as much isinglass, previously a little softened in water (though none of the water must be used), in good brandy or rum, as will make a 2-oz. phial of very strong glue, adding 2 small bits of galbanum or ammoniacum, which must be rubbed or ground until they are dissolved. Then mix the whole with a sufficient heat, keep the glue in a phial closely stoppered, and when it is to be used, set the phial in boiling water. To avoid the cracking of the phial by exposure to such sudden heat, use a thin, green, glass phial, and hold it in the steam for a few seconds before immersing it in the hot water. (2) *Dr. Ure's.*—Isinglass, 1 oz.; distilled water, 6 oz.; boil to 3 oz., and add rectified spirit, 1½ oz.; boil for a minute or two, strain and add while hot, first, a milky emulsion of ammoniac, ½ oz., and then tincture of mastic, 5 dr. (3) *Keller's.*—Soak ½ oz. of isinglass in 4 oz. water, for 24 hours; evaporate in a water bath to 2 oz., add 2 oz. rectified spirit (alcohol 85 per cent.), and strain through linen. Mix this solution while warm with a solution of best gum mastic in 2 oz. alcohol; add 1 dr. powdered gum ammoniac, and triturate together until perfectly incorporated, avoiding loss of the alcohol by evaporation as much as possible. (4) Isinglass dissolved in alcohol (by first soaking in water) 3 oz.; bottoms of mastic varnish (thick but clear) 1½ oz.; mix well.

Badigeon.—A cement used for filling up holes and covering defects in mechanical work. The most commonly used is putty, coloured to suit. Statuaries use a mixture of plaster and freestone for this purpose; carpenters, a mixture of sawdust and glue; coopers, a mixture of tallow and chalk. The same name is given to a stone-coloured mixture used for the fronts of houses, and of which the published composition is wood-dust and lime, slaked together, stone-powder, and a little umber or sienna mixed up with alum water to the consistence of cement. The real composition is probably some good hydraulic cement coloured to suit. See *Mahogany*.

Bottle.—(1) In the better class of preparations, good sealing-wax is used when the object is merely to ornament the cork. Where it is desired to close the pores of cork hermetically a softer and more tenacious cement should be used: *Chemical* or *Glycerine* are good. The following are well-tried recipes for bottle cement or bottle wax. (2) Shellac, 2 lb.; resin, 4 lb.; Venice turpentine, 1½ lb.; red lead, 1½ lb. Fuse the shellac and resin cautiously in a copper pan over the fire; when melted, add the turpentine, and lastly the red lead, which should be dry and warm. Pour into moulds, or make it into sticks by rolling on a marble slab. Care must be taken to have the red lead equally diffused through the melted mass by constant stirring, as owing to its great specific gravity it is apt to sink to the bottom. (3) Resin and beeswax, equal parts; melt together, and add sufficient Venetian red to give a good colour, and enough neatsfoot oil to prevent its being brittle when cold. (4) Sealing-wax, 1 lb.; resin, 1 lb.; beeswax, 8 oz.; melt together. Bottles may be sealed by dipping the corks in this melted mixture. If it froths, add a very small piece of tallow, and stir. (5) Resin, 15 parts; tallow, 4; beeswax, 2; melt, and colour with red ochre or ivory black. (6) Black pitch, 6 lb.; ivory black and whiting, each 1 lb. Melt the pitch and add the other ingredients hot and dry. (7) *Maissiat's.* Indiarubber is melted either with or without about 15 per cent. of either beeswax or tallow; quicklime in fine powder is gradually added, and the heat continued until change of odour shows that combination has taken place, and until a proper consistence is obtained. Used as a waterproof and air-tight covering for corks, bungs, &c. (8) Copal varnish made thick with zinc white, red lead, ivory black or any other colour, and applied like a paint.

(9) A paste composed of commercial silicate of soda and pulverized kaolin, with or without chalk, is applied to the corks, and left to dry. (10) 1 lb. rosin, ¼ lb. tallow or suet, melted together, and sufficient colouring matter stirred in. (11) 5 lb. rosin, 1 lb. beeswax. (12) To 1 lb. of (11) add 3 oz. finely powdered dry whiting, 4 oz. powdered burnt ochre (or sufficient red bole to produce the desired red tint). (13) To 1 lb. of (10) or (11) add sufficient ivory black to produce a black colour.

Brimstone.—Roll sulphur is frequently used alone as a cement for fastening iron bars in holes drilled in stone. The addition of brickdust, sand or resin, lessens its liability to crack. When the yellow colour of brimstone is an objection, a little graphite may be mixed with it.

Buckland's.—White sugar, 1 oz.; starch, 3 oz.; gum arabic, 4 oz. These should all be separately reduced to a very fine powder, and then rubbed well together in a dry mortar; then little by little add cold water until the mass is of the thickness of melted glue; put in a wide-mouthed bottle, and cork closely. The dry powder itself, thoroughly ground and mixed, may be kept for any length of time in a wide-mouthed bottle, and when wanted a little may be mixed with water with a stiff brush. It answers ordinarily for all the purposes for which mucilage is used, and as a cement for labels it is specially good, as it does not become brittle and crack off.

Canada Balsam.—(1) This material forms a very useful cement for many purposes. It is the only cement employed by opticians for uniting the lenses of achromatic objectives. For this purpose, it must be pure and colourless. It is easily bleached by exposure to sunlight. If too thick, it may be thinned with benzole. In cementing the two parts of an achromatic lens together, the surfaces should be thoroughly cleaned, and the glasses, having been previously warmed, should be laid on some surface which will not scratch them. By means of a rod of glass or metal, place a drop of balsam on the centre of one lens, and then gently lower the other down upon it. Now apply a slight pressure, and the dark disc in the centre, indicative of optical contact, will rapidly increase in size, until at last the balsam reaches the margin and begins to ooze out at the edges, if the balsam be in excess, as it ought to be. By means of a piece of soft string, if the lenses are large, or a spring clip, if they be small, the lenses should be held firmly together and exposed to a gentle heat in an oven that is cooling, or before a fire, until the balsam at the edges has become hard and dry. The string or clip may then be loosened, and all external traces of balsam removed, first by scraping, and afterwards with a little benzole or ether. The above directions, modified to suit circumstances, apply to the cementing of glasses for transparencies or opal pictures; also to the varnishing of magic-lantern slides, and the protection of any transparent surfaces from the air. (2) Canada balsam forms a very efficient and easily applied cement for the construction of small tanks used by microscopists for keeping minute plants and animals alive in water.

Cap.—Cap cements are so called because they are used for fixing brass caps, stopcocks, &c., on glass apparatus. There are two kinds of cement in use for this purpose; one consists of resin and other matters, and is fusible by heat, so that it is easily applied, takes very little time to harden, and, if the glass should get broken, or if the brass work requires to be changed, it is very easy to separate the parts by the action of heat. When properly applied, this cement is perfectly air-tight, and is very strong. The only objection to it is that it is easily softened by heat, and therefore cannot be used for apparatus to which heat is to be applied. For air-pumps and other pneumatic apparatus, and similar purposes, it answers perfectly. The other cement consists of white or red lead ground in boiled oil, and applied either to the naked surfaces, or by spreading it on a cloth, which is then placed between the surfaces to be united. The advantage of this kind of cement is that it will stand any heat below 300° F. (149° C.), and that it is steam and air tight. The objections are that it takes a long time to dry, and that when it has been used to unite pieces of apparatus, it is almost impossible to separate the parts without breaking the glass. This may occasionally be effected, however, either by heating the joint very strongly, or by soaking in solution of caustic potash or soda.

(1) *Faraday's, or Electrical.* Resin, 5 oz.; beeswax, 1 oz.; red ochre or Venetian red in powder, 1 oz. Dry the earth thoroughly on a stove at a temperature above 212° F. (100° C.). Melt the wax and resin together, and stir in the powder by degrees. Stir until cold, lest the earthy matter settle to the bottom. Used for fastening brass work to glass tubes, flasks, &c. Faraday's directions for fastening caps to the ends of tubes or retorts are as follows:—"One is to be selected of such size as to admit the tube and allow a space for cement about the thickness of a card or a little more, but the cap should never be so small as itself to gripe the glass, or any larger than is necessary to allow room for cement to surround the glass. The cement should be heated to fluidity on the sand-bath, but not to a greater degree; the cap should be warmed over a candle or lamp until it is hot enough to melt cement, and then that part of its interior which is intended to come against the glass, viz. the side of the cylinder, should be covered with the hot cement, applied by a piece of stick. The cap being then laid on its side by the sand-bath to keep it from cooling, the end of the tube or retort is next to be warmed, and a coat of cement applied on the exterior, over every part which is to come into juxtaposition with the cap, but the other parts are not to be unnecessarily soiled; so much cement is to be left adhering to the glass, that with what there is in the cap, there may be an excess above the quantity that can be retained between the glass and metal when the two are fitted together. When the cap, glass, and cement are all so warm that the latter is fluid or very soft, the cap is to be placed upon the tube, thrust into its right position, receiving a little rotary motion, at the same time to distribute the cement equally over all parts, and is afterwards to be set aside to cool. When this is well performed, the retort neck or tube should pass along until it is stopped by the inside of the shoulder; no cement should soil its interior or project within the cap, but it should fill every part between the glass and the cap to make a firm, tight junction, and project in a ring from the edge of the cap over the exterior of the glass. The superabundance is easily removed by a knife, and the annular surface left made smooth and tight by a hot wire passed rapidly over it. If a piece of cement, pushed on by the edge of the glass, project in the inside of the cap, it should when nearly cold, be cut off by a knife and removed, so that no loose fragment may remain in the retort or tube."

(2) *Varley's.* Take whiting, dry it thoroughly at a red heat, and reduce it to very fine powder. Melt together 16 parts of black resin, and 1 of beeswax, and stir into the melted mass 16 parts of the dry and warm whiting, which should not be so hot as to affect the resin. (3) *Singer's Electrical.* Resin, 20 parts; beeswax, 4; red ochre, 4; plaster-of-Paris, 1. Dry the powders thoroughly, and add them while warm to the melted resin and wax. (4) A cheaper cement, for lining voltaic troughs, is made of 6 lb. resin, 1 lb. red ochre, ½ lb. plaster-of-Paris, and ¼ lb. linseed oil. The ochre and plaster should be thoroughly dried and heated, and added to the other ingredients in their melted state. (5) *Temperatures from 212° to 300° F.* For cementing glass tubes, necks of balloons, &c., into metal mountings, where the apparatus is to be exposed to heat, a mixture of equal parts of red and white

lead is preferable to white lead alone. If possible, the surface of the glass should be roughened, and a little tow wrapped round the part where the cement is to be applied. This cement takes some time to acquire its full degree of hardness. In a week it will stand boiling water; in a month it will resist steam at 300° F. (149° C.).

(6) Equal weights red lead and white lead; preferable to white lead alone, and may be depended on for any temperature up to 212° F. (100° C.). (7) A good cement for connecting the parts of electrical or chemical apparatus may be made by mixing 5 lb. rosin, 1 lb. wax, 1 lb. red ochre, and 2 oz. plaster-of-Paris, and melting the whole with moderate heat. (8) 7 lb. black rosin, 1 lb. red ochre, ½ lb. plaster-of-Paris, well dried, and added while warm; heat the mass to a little above 212° F. (100° C.) and agitate it together, till all frothing ceases and the liquid runs smooth; the vessel is then removed from the fire, and the contents are stirred till sufficiently cool for use. (9) 4 oz. linseed oil added to the ingredients of (8).

Casein.—Casein or cheese has long been used for forming cements, either in combination with quicklime, borax, or, more recently, with silicate of soda. The most important point that requires attention, in order to secure success, is the freeing of the casein from all oily matter. Therefore, when curd is prepared from milk, use only the most carefully skimmed milk, quite free from cream. When cheese is used, select the poorest and wash it carefully. (1) Skim-milk cheese, cut in slices, and boiled in water. Wash it in cold water, and knead it in warm water several times. Place it warm on a levigating stone, and knead it with quicklime. It will join marble, stone, or earthenware so that the joining is scarcely to be discovered. See *Parabolic*. (2) Casein, dissolved in soluble silicate of soda or potash, makes a very strong cement for glass or porcelain. Take casein, free from fat, and wash until no longer acid, and silicate of soda solution (waterglass) of each as much as may be needed. Fill a bottle to ¼ of its height with damp casein; then fill the flask with silicate of soda (waterglass), and shake frequently until the casein is dissolved. (3) Take the curd of skim milk (carefully freed from cream or oil), wash it thoroughly, and dissolve it to saturation in cold concentrated solution of borax. This mucilage keeps well, and, as regards adhesive power, far surpasses the mucilage of gum arabic. It forms a valuable preparation for the laboratory, as when spread on strips of bladder it may be used to stop cracks in glass vessels, and will resist considerable heat. (4) Add ½ pint of vinegar to ½ pint skimmed milk; when the curd has settled, pour off the liquid, and wash the curd until free from acid. Add the whites of 5 eggs and beat thoroughly; mix with sufficient finely powdered quicklime to form a paste. This is an excellent cement for mending glass and earthenware. It resists water and a moderate degree of heat. (5) The chief cement used in the island of Sumatra is made from the curd of buffalo milk, prepared in the following way. The milk is left to stand till all the butter has collected at the top. The latter is then removed and the thick sour mass left is termed the curd. This is squeezed into cakes and left to dry, by which it becomes as hard as flint. For use, some is scraped off, mixed with quicklime, and moistened with milk. It holds exceedingly well, even in a hot damp climate, and is admirably adapted for mending porcelain vessels. (6) In the German cantons of Switzerland, a compound of cheese and slaked lime is used, under the name of *käsclein*, for laying floors, puttying joiners' work, making blocks for hand-printing cotton and tapestry goods, and other like purposes. The material sets so rapidly, that it is necessary to mix it as the work goes on, which entails trouble and necessitates a certain knack in its use. A Swiss chemist, Brunnschweiler, of St. Gall, has invented a preparation of lime and skim-milk, to which he gives the name of *Käsclein-pulver*, whereby these inconveniences are avoided. It is a very fine, dry powder, which keeps well, and for use only requires mixing with water, when it displays all the properties of ordinary quicklime. It sets quickly, and hardens with age. Professor Gintl, of Vienna, reports most favourably of the preparation. It is sold by C. Baumgartner and Son, of St. Gall.

Chemical.—(1) Melt yellow beeswax with its weight of turpentine, and colour with finely powdered Venetian red. When cold, it has the hardness of soap, but is easily softened and moulded with the fingers, and for sticking things together temporarily it is invaluable. The consistence of the cement may be varied by changing the proportions of turpentine and wax, and, if a very firm cement is needed, a little resin may be added. (2) Slaked lime is beaten up with white of eggs; strips of linen are soaked in the mixture, and applied immediately, as it dries very rapidly. (3) ½ lb. pulverized chalk, 1 lb. rye flour, sufficient white of egg; the whole is formed into an almost liquid mass, which is brushed over strips of linen, and the latter are applied to the joints; an additional strip of linen is laid over them, and pressed with a hot iron, which dries the compound.

Chinese, or Schio-liao.—To 3 parts of fresh-beaten blood are added 4 parts of slaked lime and a little alum; a thin, pasty mass is produced, which can be used immediately. Objects which are to be made specially waterproof are painted by the Chinese twice, or at the most three times. Dr. Scherzer saw in Pekin a wooden box which had travelled the tedious road viâ Siberia to St. Petersburg and back, which was found to be perfectly sound and waterproof. Even baskets made of straw became, by the use of this cement, perfectly serviceable in the transportation of oil. Pasteboard treated therewith receives the appearance and strength of wood. Most of the wooden public buildings of China are painted with schio-liao, which gives them an unpleasant reddish appearance, but adds to their durability. This cement was tried in the Austrian Department of Agriculture, and by the "Vienna Association of Industry," and in both cases the statements of Dr. Scherzer were found to be strictly accurate.

Chinese Glue.—(1) Shellac dissolved in alcohol. Used for joining wood, earthenware, glass, &c. This cement requires considerable time to become thoroughly hard, and even then is not as strong as good glue. Its portability is its only recommendation.

(2) A colourless cement, that is recommended highly for joining glass, crockery, stone, wood, leather, &c., is made by covering shellac with strong liquid ammonia, and shaking frequently until dissolved. The solution takes some time to form, and is facilitated by standing, placing the bottle (well stoppered) in a moderately warm situation, and briskly agitating it at intervals. It gives a strong waterproof cement, which adheres to everything. Bleached shellac gives a lighter coloured transparent solution, but the cement will not be so strong. Alcohol or wood spirit may be used in place of the ammonia, but the cement will not be so strong as where ammonia is employed. (3) Clean glass is reduced to very fine powder, and passed through a silken sieve; the powder is ground with white of egg on a stone slab, powdered glass being added till the required consistence is attained. It forms a very firm cement for glass and porcelain, vessels repaired with it breaking in a new place rather than at the joint. (4) 3 oz. shellac, 1 oz. borax, ¾ pint water; the whole is boiled in a covered vessel till dissolved, then evaporated to the proper consistence. It dries slowly, but is cheap and useful. Druggists and oilmen often employ it instead of gum, for fixing paper labels to glass or tin, when exposed to damp. (5) Bullocks' blood is mixed with ⅙ its weight of quicklime. It will scarcely keep longer than a week when the weather is warm. For use, it is thinned by addition of a little water. It is employed by bookbinders and trunk makers.

Chrome.—This cement consists of

a strong solution of gelatine, to which has been added, for every 5 parts of gelatine, 1 of a solution of acid chromate of lime. The mixture becomes insoluble in water under the action of light, in consequence of the partial reduction of the chromic acid, and this property is utilized on several occasions in photography. Professor Schwartz has been experimenting with it as a cement for glass. With a fresh preparation of the solution he covered the surfaces to be united as evenly as possible, pressed them together, and then tied them together. He then exposed the glass to the sun, and at the end of a few hours the operation had perfectly succeeded. Boiling water has no effect on the oxidized cement, and the fracture could scarcely be recognized. Valuable objects in glass, which would be disfigured with common cement, can be satisfactorily repaired in this manner. It is probable that microscopic object-glasses could be better fastened with this than with black asphalte.

Coppersmiths'.—Powdered quicklime mixed with bullocks' blood and applied immediately. Used under the edges and rivets of copper boilers, &c. Cheap and durable.

Corks.—To render corks impervious to air, acids, alkalies and corrosive liquors generally, boil them for some time in melted paraffin. They must be kept under the surface of the melted material, and should be heated and allowed to cool several times, so as to get all the air out of the pores. Corks thus treated cut easily, and make very close joints. For cements for coating cork, see *Bottle*.

Crucible.—A mixture of powdered clay and brickdust, made up with water, or a solution of borax. Used to join crucibles which are exposed to a strong heat. When mixed up with borax solution, the lute becomes a compact vitreous mass in the fire.

Curd.—(1) Skimmed milk is curdled by the addition of vinegar or rennet, and beaten to a paste with powdered quicklime. (2) ½ pint skimmed milk, ½ pint vinegar, mixed with the whites of 5 eggs; the whole is well beaten, and sufficient quicklime is added to form a paste. These cements are used for mending glass and earthenware; they resist water, and a moderate degree of heat.

Cutlers'.—This is the name given to various kinds of cement used for fastening knives, &c., in their handles. (1) A very firm cement is made of 4 parts resin, 1 of beeswax, into which, when melted, 1 part of fine brickdust is stirred. It adheres with great firmness. (2) Take powdered resin, and mix with it a small quantity of powdered chalk, whiting, or slaked lime. Fill the hole in the handle with the mixture, heat the tang of the knife or fork, and thrust in. When cold, it will be securely fastened. (3) Take 1 lb. resin and 8 oz. sulphur, melt together, form into bars, or when cold reduce to powder; 1 part of the powder is to be mixed with ½ part of iron filings, brickdust or fine sand; fill the cavity of the handle with the mixture, and insert the tang, previously heated. (4) Pitch, 4 parts; resin, 4; tallow, 2; brickdust, 2. Melt the first three ingredients, and add the brickdust hot and finely powdered. (5) Chopped hair, flax, hemp or tow, mixed with powdered resin and applied as above. (6) 16 oz. rosin, 16 oz. hot whiting, 1 oz. wax. (7) 5 parts pitch, 1 wood-ashes, 1 hard tallow, melted together. (8) 4 lb. black rosin melted with 1 lb. beeswax, and 1 lb. red hot whiting added.

Dextrine.—This is prepared from starch by the action of heat, diastase, or acids, and is sometimes called starch gum and British gum. As usually sold, it is a whitish, insipid powder, having a pleasant odour of cucumbers. It is soluble in cold and hot water, and in very dilute alcohol, but it is insoluble in strong alcohol and ether. In France it is largely employed by pastrycooks and confectioners, and by surgeons, as a stiffening for the splints used for fractured limbs. It has also been made up into roundish masses and sold for gum arabic. It is said to be used for "gumming" postage stamps, but careful trial convinced Phin that the best specimens in market are not equal to good gum arabic. It is cheaper, however, and for ordinary purposes is strong enough. Dextrine is easily prepared for use. It may be mixed with cold water and stirred or beaten for a few moments, when it will dissolve very completely. It may be used immediately, or it may be boiled. This latter improves it. For details of manufacture, see Spons' 'Encyclopædia.'

Egg.—A number of very cohesive cements, impervious to water and most liquids and vapours for a short time, are made by the union of quicklime with many of the vegetable and animal mucilages and glues. The following is said by Aiken to have been extensively employed by chemists for centuries under the name of "egg cement":—(1) Take some white of eggs with as much water, beat them well together, and sprinkle in sufficient slaked lime to make the whole up to the consistence of thin paste. This cement sets or becomes hard very quickly, and must be used at once. It is employed to mend earthenware, china, glass, marble, alabaster, spar ornaments, &c. Although waterproof to a certain extent, it does not resist moisture long unless it has been exposed to heat. (2) Freshly burnt plaster-of-Paris, 5 parts; freshly burnt lime, 1; white of egg, as much as may be needed. Reduce the two first ingredients to a very fine powder, and mix them well; moisten the surfaces to be united with a small quantity of white of egg, to make them adhesive; then mix the powder very rapidly with white of egg, and apply the mixture to the broken surfaces. If they are large, two persons should do this, each applying the cement to one portion. The pieces are then firmly pressed together, and left undisturbed for several days.

Elastic.—*Lenher's.* Indiarubber, 5 parts; chloroform, 3; dissolve and add powdered gum mastic, 1. Elastic and transparent. (2) Cut indiarubber into fine shreds and dissolve together 1 oz. of the rubber, 4 oz. of bisulphide of carbon, 2 dr. isinglass, and ½ oz. guttapercha; in using this, the parts to be joined must be covered with a thin coat of the solution, and be allowed to dry a few minutes; then heat to melting, place the parts together and compress until cold; this is useful for cementing leather or indiarubber. (Doubtful according to Phin). (3) Guttapercha, 1 lb.; caoutchouc, 4 oz.; pitch, 2 oz.; shellac, 1 oz.; linseed oil, 2 oz.; melt together. Must be heated when applied.

Engineers'.—(1) Ground white lead is mixed with as much red lead as will give the mass the consistence of putty. (2) Equal weights of white and red lead and sufficient boiled linseed oil to produce the proper consistence. These compounds are applied by smearing them on a washer of hemp yarn, placed between metallic joints, which are to be screwed up. They also answer well for luting the joints between stones, *e. g.* in cisterns, &c., and dry as hard as stone.

Fat.—(1) Clay is dried, powdered, sifted, placed in an iron mortar, and incorporated with drying oil, added gradually, the whole being well beaten up till the mass assumes the consistence of a fine paste. It should be preserved under a coating of oil, to prevent it drying up. It resists the action of corrosive gases, but inconveniently softens by exposure to heat. (2) Plaster-of-Paris mixed with water, milk, or weak glue. Stands a dull-red heat.

Fireproof.—Phin says it is easy to find a recipe for a fireproof cement, but it is very difficult to find a cement that will stand a red heat. It is well to bear in mind the fact that no cement containing organic matter (such as glue, flour, oil, &c.) can maintain any adhesive power at a red heat, since all such substances are decomposed at that temperature. Cements containing oil, &c., may do to fill cracks, but not to hold two surfaces together. No cement can be depended upon for this purpose to any great extent. For some purposes, the *Glass* cements Nos. 1 and 2 answer very well. (1) Often a lute is required to join the covers to crucibles, or for similar purposes, so as to keep them air-tight when hot. A very valuable composition of the kind is made of glass of borax (fused borax), brickdust and clay, finely powdered together and mixed with a little water when used. No very great nicety is required in the proportions, but about $\frac{1}{10}$ of borax is quite sufficient to bring the earths to that state of semi-vitrification which is desired. Litharge may be used instead of the borax, but the latter is by far the better, as it promotes that thin spreading fusion which is most efficient. (2) A cement which is said to be useful for stopping cracks in iron vessels which are intended to be strongly heated, is made of 6 parts of clay, 1 of iron filings, and linseed oil enough for mixture. The oil will, of course, be speedily destroyed, but will leave enough carbonaceous residue to unite the remainder into a firm mass. Phin would prefer, however, to depend on the *Iron* cement Nos. 2, 3, and 4. (3) The following cement is said to be very hard, and to present complete resistance alike to a red heat and boiling water:—To 4 or 5 parts of clay, thoroughly dried and pulverized, add 2 of fine iron filings free from oxide, 1 of peroxide of manganese, $\frac{1}{2}$ of common salt, and $\frac{1}{2}$ of borax; mingle thoroughly; render as fine as possible; then reduce to a thick paste with the necessary quantity of water, mixing well. It must be used immediately. After application it should be exposed to warmth, gradually increasing almost to a white heat. (4) A fireproof cement is being introduced made from a material found in the Eifel Mountains. It is alleged by eminent professional men to be the only material known to science which possesses besides its plastic qualities the virtue of being fireproof. Moistened with water, this cement forms an elastic mass, which can be exposed when dry to great heat without shrinking or showing any cracks. Such a cement should be peculiarly adapted for repairing defective fireplaces, cracks in retorts, &c., as mortar for fireproof buildings, and for the interior plastering of furnaces. The mode of its preparation is as follows: the cement is to be well mixed in a dry state, a small quantity of water is added and mixed well together. As a mortar it can be used in the ordinary way. In lining furnaces, however, care must be taken to press the cement well into the walls, so as to leave a smooth, even surface, as when dried by the air the cement easily crumbles and will not harden till ignited. Moreover it must not be treated roughly until it has been well burnt. Cracks in furnaces, retorts, &c., should be well cleansed and scraped, and if possible roughed before applying the cement. The parts to be mended should be damped beforehand. An analysis by Dr. Bischof, of Wiesbaden, gives the following results: The cement is a pale grey, gritty substance, consisting of a good deal of fine dust, with angular and round particles of quartz. When mixed with water it is very sticky, compact, and easily moulded. In 100 parts of the material dried at 248° F. (120° C.) there were:

Clay earth	10·18
Silica, chemically combined	11·03
Silica, mechanically mixed (sand)	73·58
Iron oxide	0·41
Lime	0·23
Magnesia	0·17
Potassium	0·99
Loss by heat	3·46
	100·05

As will be seen, the quantity of fusible matter, such as iron, &c., is very small indeed, if any. Under the fire treatment the cement showed the following results: After being heated to silver melting heat, or about 1832° F. (1000° C.), the cement turned to a grey colour, speckled with a few black spots, the fracture being earthy and porous.—(*Scient. Amer.*)

(5) 20 parts fine river sand, 2 litharge, 1 quicklime, sufficient linseed oil to form thin paste. Acquires a stony hardness. (6) 2 parts good clay, 8 sharp

washed sand, 1 horse-dung; mixed thoroughly, and tempered like mortar. (7) Linseed or almond meal, mixed to a paste with milk, lime-water, or starch-paste; resists a temperature of 500° F. (260° C.). (8) Clay is puddled with water, and to it is added the greatest possible quantity of sand, which has been passed through a hair sieve; the whole is worked up in the hands, and applied in coats more or less thick on vessels needing protection from the direct action of the fire. (9) 1 part of sifted manganese peroxide, 1 pulverized zinc white, sufficient commercial soluble glass to form a thin paste. To be used immediately. Becomes very hard, and presents a complete resistance to red heat and boiling water. (10) As a coating for glass vessels, to protect them from injury during exposure to fire, pipe-clay and horse-dung are made into a paste with water. This composition is applied by spreading it on paper; it is used by pipe-makers, and will stand the extreme heat of their furnaces for 24 hours without damage. (11) Shredded tow, or plumbago, is substituted for the horse-dung.

French.—Mix thick mucilage of gum arabic with powdered starch; a little lemon juice is sometimes added. Used by naturalists in mounting specimens; by artificial flower makers, and by confectioners to stick paper ornaments, wafers, papers, &c., on their fancy cakes.

Glass.—There are several kinds of so-called glass cement, said to be excellent for uniting broken glass, china, &c. (1) Pulverized glass, 10 parts; powdered fluorspar, 20; soluble silicate of soda, 60. Both glass and fluorspar must be in the finest possible condition, which is best done by shaking each, in fine powder, with water, allowing the coarser particles to deposit, and then to pour off the remainder, which holds the finest particles in suspension. The mixture must be made very rapidly, by quick stirring, and when thoroughly mixed must be at once applied. This is said to yield an excellent cement. (2) Red lead, 3 parts; fine white sand, 2; crystallized boracic acid, 3. These ingredients are mixed and fused, and then reduced to a very fine powder, which may be made into a paste with a dilute solution of soluble glass, and applied as an ordinary cement, or it may be mixed with very weak gum water (just enough gum to make it adhesive); after it has been applied, the articles are exposed to a heat sufficient to melt the fusible glass, which is formed by the union of the three ingredients. (3) 2 parts of isinglass are soaked in distilled water until soft; the water is then poured off, and as much alcohol added as will cover the isinglass, and the whole heated until solution takes place; 1 part of mastic is then dissolved in 3 of alcohol, and the two solutions mixed; 1 part of gum ammoniac is then added, the whole well shaken and evaporated in the water-bath until a thick glue-like mass is produced, becoming a stiff jelly on cooling. When required for use, the vessel containing the cement is placed in hot water or in an oven, and the cement applied by means of a brush. It hardens in 24 hours.—(*Dingler's Polytech. Jl.*) (4) Melt 5 or 6 bits of gum mastic as large as peas in the smallest quantity of alcohol; mix with 2 oz. of a solution of isinglass (made by dissolving isinglass in boiling brandy to saturation), having previously mixed the isinglass solution with 2 or 3 bits of galbanum or gum ammoniac; keep in a well-corked bottle, and gently heat before using. (5) With a small camel-hair brush, rub the edges with a little carriage oil-varnish, and, if neatly put together, the fracture will hardly be perceptible, and, when thoroughly dry, will stand both fire and water. (6) Dissolve fine glue in strong acetic acid to form a thin paste. (7) Canada balsam or clear glue (gelatine), to which has been added a small quantity of bichromate of potash. The latter soon loses its yellow tint, and becomes unaffected by damp when exposed to daylight. (8) 2 parts of common black pitch and 1 part guttapercha, melted and worked together till mixed; or 2 parts shellac, 1 part Venice turpentine, melted together. These would want using warm. They are both impervious to weather influences. (9) See *Chrome*.

Glass to Metals.—(1) A cement of great adhesive property, particularly serviceable in attaching the brass mountings on glass lamps, as it is unaffected by petroleum, may be prepared by boiling 3 parts of rosin with 1 part of caustic soda, and 5 parts of water, thus making a kind of soap which is mixed with ½ of its weight of plaster-of-Paris. Zinc white, white lead, or precipitated chalk, may be used instead of the plaster, but when they are used the cement will be longer in hardening. (2) A cement for such purposes as fixing metal letters to glass windows consists of copal varnish 15 parts, drying oil 5 parts, turpentine 3 parts, oil of turpentine 2 parts, liquefied marine glue 5 parts. Melt in a water-bath, and add 10 parts dry slaked lime. (3) Brass letters may be securely fastened on glass windows by the following recipe:—

Litharge	.. ..	2 parts.
White lead	.. ..	1 ,,
Boiled linseed oil	..	3 ,,
Gum copal	.. ..	1 ,,

Mixed just before using, this forms a quick drying and secure cement. (4) 1 lb. of shellac, dissolved in a pint of strong methylated spirit; to which is to be added $\frac{1}{20}$ part of a solution of indiarubber in carbon bisulphide. (5) Take 2 oz. of a thick solution of glue, and mix with 1 oz. of linseed oil varnish, or ¼ oz. of Venice turpentine. Boil together, agitating until the mixture becomes as intimate as possible. The pieces cemented should be fastened together for a space of 48 to 60 hours. (6) One of the best cements for uniting glass to other substances is prepared by putting the best and purest gum arabic into a small quantity of water, and leaving it till next day, when it should be of the consistence of treacle. Calomel (mercurous chloride or subchloride of mercury) is then added in suitable quantity, enough to make a sticky mass being well mixed on a glass plate with a spatula. No more is to be made than that required for immediate use. The cement hardens in a few hours, but it is wiser to leave it for a day or two. To ensure success it is necessary to use only the very best gum; inferior sorts are absolutely useless. (7) Before glass can be soldered to metal, it must be "quicked" upon the side that is to be soldered. The "quicking" process is similar to, if not identical with, the method of silvering looking-glass. When the glass is quicked, it may be readily soldered to the metal, using Venice turpentine or chloride of zinc as a flux. (8) 60 parts starch, 100 finely pulverized chalk, are made into a mixture with equal parts of water and spirit, and the addition of 30 parts Venice turpentine, taking care to agitate the mass with a stick, so as to ensure its homogeneity. (9) 4 parts glue melted with the least possible quantity of water, 1 part Venice turpentine; will resist moisture. (10) That solder in some form adheres to glass is well known and practised by the makers of fictitious jewellery. These are made up of pieces of black glass, cut and polished, and fairly soldered on to metal plates. By breaking one of these across, it will at once be seen how strong the adherence really is. If the work has been well done, the pieces of glass do not fly off, but are difficult to remove except in fragments This soldering is done as follows:—The shields, or metal plates, are coated with a thick layer of tin; these, together with the appropriate pieces of glass, are laid on an iron plate, heated to the melting-point of the tin. The piece of hot glass to be soldered is then picked up with forceps, and its edge introduced under the surface of the melted stratum of tin, and slid forward so as to carry some of the metal before it, thus skimming off the oxidized surface so as to bring clean glass and clean metal in absolute contact. No glue must be used; the least trace of oil or resin will spoil the operation. When the piece of glass is fairly in place, it is pressed down in order to squeeze out the surplus solder. It is this sliding action that ensures success; if the glass were to be directly pressed down upon the tin solder, no adhesion would take place at all, from the presence of a trace of oxide and the existence of an air film. The glass, of course, must be polished and perfectly clean.—(F. H. Wenham.)

Glue.—(1) Glue is, undoubtedly, the most important cement used in the arts. It serves to unite wood, paper, and almost all organic materials. The carpenter, the cabinet maker, the bookbinder, the hatter, and numerous other trades use it extensively, and in some cases to the exclusion of everything else. Good glue, properly prepared and well applied, will unite pieces of wood with a degree of strength which leaves nothing to be desired. The fibres of the hardest and toughest wood will tear asunder before the glued surfaces will separate, and certainly anything more than this would be unnecessary. Bevan found that when two cylinders of dry ash, each 1½ in. diameter, where glued together, and then torn asunder after a lapse of 24 hours, it required a force of 1260 lb. to separate them, and consequently the force of adhesion was equal to 715 lb. per sq. in. From a subsequent experiment on solid glue, he found that its cohesion is equal to 4000 lb. per sq. in. This would indicate that our methods of applying this substance as a cement are capable of improvement, and it is undoubtedly true that great care and skill must be used if the best results would be obtained.

Good glue is hard, clear (not necessarily light-coloured, however), and free from bad taste and smell. Glue which is easily dissolved in *cold* water is not strong. Good glue merely swells in cold water, and must be heated to the boiling-point before it will dissolve thoroughly. Good glue requires more water than that which is poor. The best glue, which is clear and red, will require from one-half to more than double the water that is required with poor glue. From careful experiments with dry glue immersed for 24 hours in water at 60° F. (15½° C.), and thereby transformed into a jelly, it was found that the finest ordinary glue, or that made from white bones, absorbs 12 times its weight of water in 24 hours; the glue from dark bones, 9 times, while the ordinary glue made from animal refuse, absorbs but 3 to 5 times its weight of water.

The quality of glue may, to a certain extent, be estimated by breaking a piece. If good, it will break hard and tough, and when broken will be irregular on the broken edge. If poor, it will break comparatively easy, leaving a smooth straight edge.

Glue is insoluble in alcohol, though a small quantity of alcohol may be mixed with the solution without difficulty; but if too much alcohol be used, the glue separates from the water and falls to the bottom of the vessel in the form of a white viscid substance. Neither does it dissolve in ether, or in the fixed or the essential oils, although oily matters of all kinds may be incorporated with the solution of glue, forming a sort of emulsion. These facts will enable readers to judge of the value of those recipes in which they are directed to dissolve glue in alcohol or in oil, for the purpose of making a glue which will remain liquid at all times. A little alcohol may be added, but if the amount of alcohol be sufficient to produce any marked effect, the glue is apt to separate. One of the most marked characteristics of good glue is its property of gelatinizing. By this is meant the fact that a moderately strong solution of glue which is quite fluid when hot, forms a stiff jelly when cold. This property is no bad test of the quality of glue. The firmer the jelly, the better the glue. In ignorance of this principle, some persons have made great efforts to get rid of this property, and acids and various salts have been added to the solution of glue for the purpose of preventing its gelatinization, and thus retaining it in a liquid form that would be ready for use at any moment. But by those who have devoted the most careful attention to the subject, the fact stands unquestioned that the strongest glue is that which is purest and which gelatinizes or sets most completely.

Glue being an animal substance, it must be kept sweet, and free from putrefaction; to do this it is necessary to keep it cool after it is once dissolved, and while not in use.

The most serious defects in glue are the mixture of extraneous matters and incipient putrefaction. There are other substances, beside gelatine, present in the matters from which glue is prepared, and unless these substances are carefully separated, the glue will prove of inferior quality. Hence, in selecting glue, choose that which is transparent and free from clouds or flocks in its substance. Very clear and colourless glue is by no means the best; but, whatever be the colour, see that it is clear. It is true that in some cases very finely divided powders have been added to glue with the avowed object of rendering it stronger. Phin is inclined to believe, however, that such additions serve merely to cloak defects in the glue itself, or in the mode in which it is applied. Peter Cooper is said to add very finely divided Paris white to his glue, and it is claimed that the glue is improved not only in appearance but in actual strength. White lead added to glue is said to make it waterproof as well as to strengthen it, and from the well-known relation of white lead to oils and animal substances it is not impossible that this may be the case.

The other and by far the greatest and most common defect in glue is incipient putrefaction. This may occur either at the glue-factory or in the workshop of the mechanic; in either case it is fatal to the strength of the glue. It may often be detected, however, by the smell and taste. The odours of good glue and of that which has begun to decay are so different that, once observed, they will never be forgotten. Glue which has begun to putrefy at the factory may not exhibit any odour so long as it is kept perfectly dry, and it may even have been so deodorized by bone black or the action of chemicals, that it does not exhibit a bad odour when first moistened. But when allowed to stand for a very short time, especially in warm weather, putrefaction again commences, and the odour is quite perceptible, while good glue will remain sweet and sound under the same conditions.

Glue which exhibits a bad odour when moistened should be rejected and used only for making size, and for uniting the coarser varieties of articles; and when the glue-pot begins to exhibit any signs of putrefaction, it ought to be carefully cleaned out and thoroughly soaked and washed, for the presence of a little bad glue will soon destroy a whole batch of a good article.

The preparation of glue demands care rather than skill. In dissolving glue, it is best to weigh the glue, and weigh or measure the water. If not done there is a liability of getting more glue than the water can properly dissolve. It is a good plan, when once the quantity of water that any sample of glue will take up has been ascertained, to put the glue and water together at least 6 hours before heat is applied, and if not soft enough then, let it remain longer in soak, for there is no danger of good glue remaining in pure water, even for 48 hours, provided the weather be cold; but it must not be allowed to lie too long in that liquid, or it will begin to decay, especially in warm weather. To meet this difficulty, and secure the quick soaking of the glue, there has of late years been introduced a pulverized or granulated article which is excellent. Frozen glue, made porous by freezing, is also used with this object in view. After being soaked, the glue should be melted, great care being taken that it be not burned. Next to putrefaction, burning is the great destroyer of glue. Burnt glue is always weak. If kept dry, glue may be preserved for any length of time; but when once moistened, even the best samples soon spoil. No more glue should be prepared at any one time than is to be used immediately, and whenever a job requiring extra strength is to be executed, it will always pay to prepare a fresh lot. Formerly, when glue was generally heated over the naked fire, the old-fashioned glue-pot was always used.

This pot is double—the space between the outer and inner vessels being filled with water. Consequently where this pot is employed, the glue can never be made hotter than boiling water, and thus all danger of burning is avoided. Now that more delicate and convenient modes of heating have been devised, this old pot has in some cases been dismissed, to the evident deterioration of the process. Even steam should never be employed except to heat water in the outer case. In applying glue, it should be remembered that the thinner the layer which is applied the stronger will be the joint, and the less water there is combined with the glue the sooner will it dry, and consequently the less will the joint be exposed to accidental disturbance before union has fairly occurred. Carpenters should remember that fresh glue dries more readily than that which has been once or twice melted.

If glue is of first-rate quality, it can be used on most kinds of woodwork very thin, and make the joint as strong as the original, but it is necessary that the glue be brought into intimate contact with the entire surface of the wood.

A drop of melted glue allowed to simply fall on a surface of dry, cold wood and dry there, will often fail to adhere at all, while if the same drop had been rubbed in, it would have attached itself to the surface with wonderful tenacity. In applying glue, therefore, we must secure this perfect contact, and we must also employ every means in our power to delay the gelatinization of the glue until the joint has been completed. The glue should therefore be used while very hot, as hot as it will bear, and in very cold weather the wood itself should be warmed. The glue should be well rubbed in with a stiff brush and the two surfaces should be rubbed well together and retained in contact under great pressure until the glue has become somewhat dry. Complete dryness rarely takes place under several days; but after the lapse of 12 hours, the joint becomes tolerably strong. A joint made in this way is probably as strong as can be made by any ordinary process. (Phin.)

Holding Power of Glue.—From numerous experiments, Dr. Karmarsch has arrived at the following conclusions:—

1. Glue exerts a far greater hold on surfaces of wood cut across the grain than on those that have been split or cut with the grain.

2. Where two surfaces of split wood are laid together, the hold of the glue is the same, whether the fibres are laid parallel or crosswise to each other.

3. The holding power of glue on different woods, estimated in kilogrammes per square centimetre, is as below:—

	Cut across the grain.	Split.
Beech	155·55	78·83
Hornbeam. ..	126·50	79·16
Maple	87·66	63·00
Oak..	128·34	55·16
Fir	110·50	24·16

(*Moniteur Indust. Belge.*)

To Prevent the Cracking of Glue.—When articles that have been glued are exposed to great heat, they are often much damaged by the cracking of the glue. This evil may be avoided by adding to the glue chloride of lime, which is a very soluble salt, and prevents the glue from drying so as to become brittle. Glue so prepared adheres firmly to glass, metal, &c., and may be used for sticking on tickets so as not to come off. (*Pharm. Zeitsch. of Russia.*)

Application.—The preparation of glue is very simple. It is first broken up into small pieces and put into a vessel, covered with cold water, and left to soak for a number of hours, the length of time required for soaking being generally governed by the strength of the glue, the strongest glue taking the longest time. After being soaked until it all swells and becomes soft and gelatinous (avoid over-soaking), it is placed upon the fire to cook, being kept stirred until it is thoroughly dissolved and appears stringy. It is then ready for use; but in factories where a large quantity is employed, it is then poured out in a large flat pan and left to cool; and the workman, when desiring it for use, cuts off the required quantity and heats it. It is a bad habit for workmen to allow the glue-pot to remain on the stove after they have done with it, as a very prolonged heat will destroy the adhesive qualities of the glue. Glue, to resist well a damp atmosphere, should contain as little saline matter as possible. When buying the article, venture to apply your tongue to it, and if it tastes salt or acid reject it for any but the commonest uses. The same operation will also bring out any bad smell the glue may have. Those are very simple and ready tests, and are the usual ones by which dealers and large consumers form their judgment. Another good test is to soak a weighed portion of dry glue in cold water for 24 hours, then dry it again, and weigh. The nearer it approaches to its original weight, the better glue it is, thereby showing its degree of insolubility. Glue loses much of its strength by frequent re-melting. Therefore, glue which is newly made is preferable to that which has been re-boiled. The hotter the glue the more force it will exert in keeping the joined parts glued together. In all large and long joints it should be applied immediately after boiling. Apply pressure until it is set or hardened.

In applying glue, where the part is end grain, first fill the pores of the wood with thin glue, and let dry; then clean off, and glue it at the joint with strong glue. Many a job has been spoilt by reason of neglecting to fill the end grain in this manner. In adding water to glue, it is best to give the glue a boil before using again, so that it may be evenly and thoroughly mixed.

Quick Drying Glue.—Put your glue into a bottle ⅔ full, and fill up with common whisky; cork tight, and set by for 2 or 3 days, and it will dissolve without the application of heat, and will keep for years. (For manufacture of glue, see article *Gelatine.*)

Fish Glue.—(1) An attempt has been made to prepare glue from the skins and refuse of fish, in the same way that ordinary glue is prepared from the skins and offal of land animals. Such glue has been made in large quantity, and forms a very good size for some purposes. Thus far, however, it has been found impossible to free it from a very disagreeable fish-like odour, and another objection is, that it does not gelatinize. It is probable that by exercising greater care and by using the skins alone, freeing them from scales and oil, a very strong and serviceable glue might be prepared. The ordinary method at present in use for curing fish, will, probably, at no distant day, give place to others by which the product will be more condensed and more palatable. In that case, it is probable that fish skins will be an important part of the refuse, and a method of obtaining good glue from them will be a most valuable process. That there is no inherent difficulty with mere fish product is shown by the manufacture of isinglass, which is one of the strongest glues. The northern seas will probably be the chief seats of this new industry, as the skins can there be subjected to the processes required, without such danger from putrefaction as exists in warm climates. See *Lapland Glue.*

(2) A correspondent of a technological paper describes a method of preparing glue from fish scales. He says: "The natives of the Maldive and Laccadive Islands, and the Malays of the coasts of Borneo and Sumatra, have a glue which they make as follows:—They take the scales of a kind of fish, called by English and American sailors salt-water trout (identical with the salt-water trout of the Gulf of Mexico), and after thoroughly washing them in a glazed earthen jar, which they stopper tightly, and weight so that it will remain under water, they put this jar in a pot of water, and boil it until the scales are reduced to a semi-transparent viscous mass. This requires several hours. Care should be taken that no water or extraneous matter, fluid or

solid, be allowed to get into the jar with the scales. The glue thus made is the most tenacious, and at the same time the most transparent and beautiful that I have ever seen. I have made it in this country from the scales of perch, trout, and bass. I am informed that a similar glue is made from the bladders of various fishes."

Lapland Glue.—The bows of the Laplanders are composed of two pieces of wood, glued together. One of them is of birch, which is flexible, and the other of the fir of the marshes, which is stiff, in order that the bow when bent may not break, and when unbent it may not bend. When these two pieces are bent, all the points of contact endeavour to disunite themselves, and to prevent this the Laplanders employ the following cement: They take the skins of the largest perches, and having dried them so that the greasy part may be removed by scraping and wiping, and the oil soaked out by any porous material, they soak them in water until they are so soft that they may be freed from the scales, which are thrown away. They then put 4 or 5 of these skins in a reindeer's bladder, or they wrap them up in the soft bark of the birch tree, in such a manner that water cannot touch them, and place them thus covered in a pot of boiling water with a stone above them to keep them at the bottom. When they have boiled about an hour, they take them from the bladder or bark, and they are then found to be soft or viscous, like strong glue. In this state they employ them for gluing together the two pieces of their bows, which they strongly compress together and tie up until the glue is well dried. These pieces never afterward separate.

Liquid Glue.—Various attempts have, as already stated, been made, with the intention of retaining the glue in a liquid form, and of thus avoiding the inconvenience attending the use of a cement which requires to be liquefied by heat whenever it is to be used. The addition of a little nitric acid will prevent the glue from gelatinizing or becoming solid, and the same effect is produced by the addition of a little vinegar, or of pyroligneous acid, which will also prevent it from moulding. It is supposed that the latter is substantially the formula for making the well-known Spaulding's glue. The addition of these substances injures the glue, however. Spaulding's glue may be more convenient than common glue, but it is far inferior to it in strength. More recently it has been proposed to add sulphate or chloride of zinc to common glue for the purpose of keeping it liquid. A solution of shellac in alcohol has been used and highly extolled as a substitute for common glue. It forms a tolerable liquid cement, but is far inferior to glue. Any of the following recipes will afford a liquid glue which will answer well enough for purposes where no great strength is required; but there is no cement which is more convenient than common glue, and yet which will unite wood with anything like the efficiency of that article.

(1) Dumoulin's. This is one of the oldest forms and one of the best; it is prepared as follows: Soak 8 oz. of best glue in ½ pint of water in a wide-mouthed bottle and melt by heating the bottle in a water-bath. Then add slowly 2½ oz. of nitric acid, sp. gr. 1·330, stirring constantly. Effervescence takes place under escape of nitrous acid gas. When all the acid has been added, the liquid is allowed to cool. Keep it well corked, and it will be ready for use at any moment. It does not gelatinize, nor putrefy, nor ferment. It is applicable to many domestic uses, such as mending china, wood, &c. (2) A very strong glue may be made by dissolving 4 oz. of glue in 16 oz. of strong acetic acid by the aid of heat. It is semi-solid at ordinary temperatures, but needs only to be warmed, by placing the vessel containing it in hot water for a short time, to be ready for use. (3) Dilute officinal phosphoric acid with 2 parts, by weight, of water, and saturate with carbonate of ammonia; dilute the resulting liquid, which must be still somewhat acid, with another part of distilled water, warm it on a water-

bath, and dissolve in it enough good glue to form a thick, syrupy liquid. It must be kept in well-closed bottles. (4) Spaulding's. This is simply good glue prepared with strong vinegar instead of water. Dilute, *rectified* pyroligneous acid, which is a coarse form of vinegar containing a very little creosote, may be used. It prevents mould and fermentation. (5) Glue, water and vinegar, of each 2 parts. Dissolve in a water-bath, and add alcohol 1 part. (6) A solution of shellac in alcohol is often sold under the name of "liquid glue." See *Chinese Glue.* (7) Macerate 6 parts glue in 16 of water, until the glue is swollen and soft. Add 1 of hydrochloric acid, and 1½ sulphate of zinc, and let the mixture be kept for 10 or 12 hours at a temperature of 154° to 158° F. (68° to 70° C.). Answers admirably for attaching labels to tin and to glass when exposed to damp. (8) The writer of the following claims to have a personal knowledge of its excellence: "An excellent liquid glue is made by dissolving glue in nitric ether. The ether will only dissolve a certain amount of the glue: consequently, the solution cannot be made too thick. The glue thus made is about the consistency of molasses, and is doubly as tenacious as that made with hot water. If a few bits of indiarubber, cut into scraps the size of a buck-shot, be added, and the solution allowed to stand a few days, being stirred frequently, it will be all the better, and will resist dampness twice as well as glue made with water." (9) Puscher states that a clear liquid glue may be obtained by dissolving 1 part of sugar in warm water, adding ¼ part of slaked lime, and keeping at 145°–165° F. for several days, with shaking at intervals. From 4 to 5 parts of the resulting solution of sugar-lime are then used to dissolve 1 part of glue, the whole being gently warmed. The addition of 2 to 3 per cent. of glycerine improves the glue, and a few drops of lavender oil remove the peculiar odour. (10) Ordinary glue, 100 oz., is dissolved in a water-bath with 250 oz. vinegar; when the whole has become liquid, 250 oz. ordinary alcohol, and 10 oz. alum are added, the mass being kept over a fire for a quarter of an hour. It is very tenacious, and does not become putrid. When too thick, a little water may be added, and the mixture may be heated. It is very useful for cementing, in the cold, a variety of small objects, and is much employed by the makers of false pearls. (11) 100 parts of ordinary gelatine are dissolved in 400 parts of water containing 6 to 7 parts of oxalic acid. The solution is kept for 5 or 6 hours on the water-bath in a porcelain infusion pot, after which it is neutralized with carbonate of calcium, the insoluble precipitate filtered off, and the clear filtrate evaporated at a moderate temperature, until about 200 parts are obtained. The product is a durable, slightly-tinted, but clear liquid glue.

Mouth or Lip Glue.—Mouth glue forms a very convenient portable cement of considerable adhesiveness. For some purposes, especially for attaching drawing-paper to a board, it is the most convenient form, but for ordinary desk use, the mucilage bottle is to be preferred. Mouth glue may be purchased in cakes from the dealers in artists' supplies. Those who attempt to make it themselves should use a very pure form of glue or gelatine, quite free from smell or taint, as this will prove very disgusting when the glue is moistened with the lips. Sugar is generally added, not for the purpose of sweetening the article, but to render it more soluble. It will be found that a pure, but dark brown sugar is better than a white article, and a little syrup or molasses better than either. When molasses is substituted for sugar, the quantity employed may be greatly diminished. Phin uses a nice article of common glue instead of the so-called mouth glue. It requires a little more rubbing than the mouth glue, but it holds more strongly, and resists better the wetting to which mechanical and architectural drawings are subjected.

(1) Soak 4 oz. best glue and 1 oz.

isinglass in water until soft. Pour off the superfluous water, and add 1 oz. brown sugar. Melt the whole together with a gentle heat, and allow it to evaporate until quite thick. Pour into a flat-bottomed dish that is quite cold; if placed on ice, so much the better, as it will prevent the glue sticking to it. When solid, cut into cakes. (2) Glue, 5 oz.; sugar, 1 oz.; dissolved in water, boiled down, poured into moulds, and dried. (3) Isinglass and parchment glue, each 1 oz.; sugar candy and gum tragacanth, each 2 dr.; add to them 1 oz. of water; boil the whole till the mixture appears, when cold, of the consistence of glue. Then form it into small rolls for use. This glue, wetted with the tongue and rubbed on the edges of the paper, silk, &c., to be cemented, will, on their being laid together and suffered to dry, unite them as firmly as any other part of the surface.

Portable Glue.—Put a pinch of shredded gelatine into a wide-mouthed bottle; put on it a very little water, and about ¼ of glacial acetic acid; insert a well-fitting cork. If the right quantity of water and acid be used, the gelatine will swell up into worm-like pieces, quite elastic, but at the same time, firm enough to be handled comfortably. The acid will make the preparation keep indefinitely. When required for use, take a small fragment of the swelled gelatine, and warm the end of it in the flame of a match or candle; it will immediately "run" into a fine clear glue, which can be applied at once direct to the article to be mended. The thing is done in half a minute, and is, moreover, done well, for the gelatine so treated makes the very best and finest glue that can be had. This plan might be modified by dissolving a trace of chrome-alum in the water used for moistening the gelatine, in which case, no doubt, the glue would become insoluble when set. But for general purposes, there is no need for subsequent insolubility in glue.

Glycerine.—(1) In 1869, Hirzel obtained, by triturating litharge with glycerine, a mass which he found useful as a cement for vessels containing benzol, ethereal oils, &c., as it possessed the property of soon hardening. During the same year, Pollack recommended the same mass as a cement for stone and iron ware, and pointed out that it was attacked only by strong acids; also, that its durability is the greater, the more water the litharge had absorbed, since the latter, when entirely dry, yielded a cement of feeble adhesiveness only. Ross, in 1870, found this cement proof against concentrated [?] and diluted acids, alkaline lyes, ether, alcohol, benzol, and carbon bisulphide.

The somewhat contradictory statements regarding the power of resistance against acids of this cement, as well as the desire to find out whether glycerine entered into a chemical combination with litharge, led Theodor Morawski to investigate the subject. He obtained a definite compound, crystallizing in fine needles, which was found to be a glyceride of lead.

From a large number of experiments instituted to ascertain the most favourable conditions for the production of a perfect cement, Morawski obtained the following results: The hardest cement is produced by triturating 50 *grm.* (1¾ oz.) of litharge with 5 *cc.* (⅓ cub. in.) of glycerine. If more glycerine is used, the mass hardens much more slowly and imperfectly.

The small proportion of glycerine, however, makes it impracticable to prepare large quantities of the cement at a time. For this purpose, it will be necessary to take more glycerine, in order to facilitate the trituration. But as it was also proved that the addition of a small quantity of water produced an equally durable cement, provided the proper proportions are observed, he found, after many trials, that the most favourable results are obtained by adding 2 volumes of water to 5 of glycerine (sp. gr. 1·240); 6 *cc.* of this liquid are incorporated with 50 *grm.* of litharge. This mass requires a shorter time than any other proportions to produce a hard cement, 10 minutes only being required to harden moderately, while, after 2 hours, it becomes even harder than any mixture containing litharge with glycerine alone. But, after a few days, the latter compound (prepared without water) overtakes the former in hardness, and remains so. If it is desired to produce a cement which rapidly hardens, and still has considerable firmness, it is advisable to use water with the glycerine.—*Dingler's Polyt. Journal.*

The applications of this cement are innumerable. Chemists and others know well the difficulty of keeping very volatile liquids. Bottles of ether, for example, are shipped for India, and when they arrive are found to be more than half empty. The chemist sometimes puts a bottle of benzole or bisulphide of carbon on his shelves, and when he next requires it, he finds the bottle empty and dry. The usual remedy for this is a luting of melted sulphur, which is difficult to apply and hard to remove. Glycerine cement, however, is easily prepared and applied, and is said to prevent the escape of the most volatile liquids. It is merely painted around the cork or stopper. It quickly dries, and becomes extremely hard, but can be easily scraped off with a knife, when it is necessary to open the bottle.

(2) *Pollack's.* Litharge and red lead, equal parts: mix thoroughly, and make into a paste with concentrated glycerine to the consistence of soft putty. This cement takes some time to dry, but it turns almost as hard as stone, and resists moisture and heat very well. Pollack used it to fasten the different portions of a fly-wheel with great success; while when placed between stones and once hardened, it is easier to break the stone than the joint.

Gum Arabic.—Gum arabic is the product of various species of *Acacia.* It is the material from which true mucilage is made, and it forms one of the most valuable cements. Faraday says there is no cement which exceeds it in strength. Pure gum arabic is in roundish or irregular pieces of various sizes, more or less transparent, hard, brittle, and breaking with a shining fracture. It is usually white or yellowish white, but frequently presents various shades of red, and is sometimes of a deep orange or brownish colour. In powder it is always more or less purely white. It is liable to adulteration both in powder and in masses. Much of the white gum arabic of the shops, consists of the cheaper and coarser gum Senegal, bleached by what is called "Picciotto's process." The gum is dissolved in water, and sulphurous acid gas passed through the solution. The liquid is afterwards boiled to expel the sulphurous acid, a little of which, however, still remains behind. The product is very white, but lacks the peculiar toughness and adhesiveness of the best gum.

The powdered gum is frequently adulterated with dextrine, gum Senegal, starch, sugar, cherry-tree gum, &c. These substances are not difficult of detection, but where a good article is required for preparing a cement, it is best to purchase gum arabic in lump from a reliable dealer, taking care, in any case, to avoid the bleached article. Powdered gum has no advantage, except in the fact that it dissolves more quickly than when in lumps. It, therefore, forms, when in this state, a very convenient and portable cement, which may be made ready in an instant by the addition of a little water.

For preparing gummed surfaces which will adhere when moistened (such as gummed labels, &c.), there is no material superior to gum arabic. The great difficulty with gum arabic, and, indeed, with other gums and pastes, lies in the fact that when *thoroughly* dry, they become brittle, so that the label or other object falls off. A simple remedy for this difficulty lies in the addition of 5 to 10 drops of glycerine to each fl. oz. of mucilage or paste. Gum arabic is used not only alone, but when mixed with other matters. The following formulæ produce very good cements. (1) Rub together, in a mortar, 2 parts nitrate of lime, 25 of water, and 20 of powdered gum arabic. This forms a transparent cement of great strength, and applicable to wood, porcelain, glass, and stone. The surfaces to be united should be painted with the cement, and firmly bound together until the drying is complete. (2) A white paste, adhesive to most surfaces, is said to be made as follows: A solution of 2½ oz. gum arabic in 2 qt. of warm water, is thickened with flour paste well boiled, and to this is added a solution of alum and sugar of lead, 720 gr. each, in water; the mixture is heated and stirred till about to boil, and then cooled. It may be thinned, if necessary, with the gum solution. It will be seen that this mucilage consists of a solution of gum arabic and flour paste in acetate of alumina, coloured white with sulphate of lead. (3) To 250 grm. (9 oz.) of mucilage prepared by dissolving 2 parts of gum in 5 of water, add 2 grm. (30 gr.) of crystallized sulphate of aluminium dissolved in the least possible quantity of water. A solution of alum does not answer as well as the simple sulphate of alumina, which can be prepared from alum by precipitating the alumina with ammonia, washing thoroughly on a filter, and dissolving in sulphuric acid. The mucilage thus prepared does not sour or mould, and may be used as a cement for general purposes. (4) It is said that a mixture of 1 part dry chloride of calcium, or 2 parts of the same salt in the crystallized form, and 36 parts gum arabic, dissolved in water to a proper consistency forms a mucilage which holds well does not crack by drying, and yet does not attract sufficient moisture from the air to become wet in damp weather.

Gum Tragacanth.—(1) Known amongst mechanics as gum dragon and gum drag. It comes in irregular shaped fragments, varying in size from that of a small pea to a hazel nut or larger. It is yellowish-white, and sometimes translucent like horn. It is hard and tough, and very difficult to reduce to powder unless when exposed to a freezing temperature, or when thoroughly dried and ground in a heated mill or mortar. When so treated, however, it is possible to produce a very fine white powder. When thrown into water, it absorbs that liquid, and swells up and forms a paste which is largely used by shoemakers, and by manufacturers of lozenges, as it gives great toughness to the mass of sugar and other ingredients. If sufficient water be used, and the soft mass be heated or mixed up, it forms a uniform, soft, adhesive paste. If allowed to settle, however, part of the gum separates from the water, and is deposited. Boiling water dissolves the gum more perfectly at first, but even when so treated, it separates afterwards. According to Planche, a mixture of gum tragacanth and gum arabic forms, with water, a thinner mucilage than the same quantity of either of these gums alone. (2) Equal parts of tragacanth powder and powdered gum arabic, moistened, according to requirements at the time, with dilute acetic acid, or, if the colour will not be of any importance, with ordinary vinegar. This forms a very strong mucilage which keeps well.

Hensler's. — Litharge, 3 parts; quicklime, 2; white bole, 1; grind up with boiled linseed oil. Forms a very tenacious and hard cement, but one that takes a long time to dry. It is used for china, glass, &c.

Indiarubber.—(1) Pieces of indiarubber may be readily united by means of the pasty mass obtained by acting upon pure rubber by its appropriate solvents. These are: Sulphuric ether, coal-tar naphtha, bisulphide of carbon, caoutchoucin, and oil of turpentine. But as it is difficult to dissolve rubber satisfactorily on a small scale, and as the cement may be bought ready made at a cheap rate, it is hardly worth while to enlarge upon its preparation. Those who wish to try it will probably succeed best by cutting pure rubber (not that which has been vulcanized) into very thin slices, boiling it in water so as to soften and expand it, and then digesting it in hot coal-tar naphtha, or oil of turpentine. Several days are required to effect the solution. When this cement is used for uniting pieces of rubber, the surfaces which are to be joined must be fresh; the surfaces should therefore be either pared with a knife or rasped with a file. They may then be coated with the cement, pressed firmly together, and exposed to a gentle heat for a few days. (2) For mending indiarubber shoes, boots, and apparatus where the regular rubber cement cannot be obtained, the following directions have been given: Cut 2 lb. indiarubber into thin, small slices; put them in a vessel of tinned sheet-iron, and pour over 12 to 14 lb. of bisulphide of carbon. For the promotion of solution, place the vessel in another containing water previously heated up to about 86° F. (30° C.). The solution will take place promptly, but the fluid will thicken very soon, and thus render the application difficult, if not impossible. In order to prevent this thickening, a solution of indiarubber and resin in spirits of turpentine must be added to the solution of indiarubber in bisulphide of carbon, and in such quantity that the mixture attains the consistency of a thin paste. The solution of indiarubber and resin in spirit of turpentine should be prepared as follows: Cut 1 lb. of indiarubber into thin, small slices; heat in a suitable vessel over a moderate coal fire, until the indiarubber becomes fluid; then add $\frac{1}{2}$ lb. powdered resin and melt both materials at a moderate heat. When these materials are perfectly fluid, then gradually add 3 or 4 lb. spirit of turpentine in small portions, and stir well. By the addition of the last solution, the rapid thickening and hardening of the compound will be prevented, and a mixture obtained which fully answers the purpose of gluing together rubber surfaces, &c. (3) It is said that a good cement, that will render indiarubber in any form adherent to glass or metal, may be made as follows: Some shellac is pulverized, and then softened in 10 times its weight of strong ammonia, whereby a transparent mass is obtained, which becomes fluid after keeping some little time, without the use of hot water. In 3 or 4 weeks the mixture is perfectly liquid, and, when applied, it will be found to soften the rubber. The rubber hardens as soon as the ammonia has evaporated again, and thus becomes impervious to both gas and liquids. For cementing the rubber sheet, or the material in any shape, to metal, glass, and other such surfaces, the cement is strongly recommended. (4) Virgin or native indiarubber is cut with a wet knife into the thinnest possible slices, which are then divided by shears into threads as fine as small twine. A small quantity of the shreds (say $\frac{1}{10}$ of the capacity of the bottle) is then put into a wide-mouthed bottle, and the latter is three-fourths filled with benzine of good quality, and perfectly free from oil. The rubber almost immediately commences to swell, and in a few days, if often shaken, it will assume the consistence of honey. Should it be inclined to remain in undissolved lumps, more benzine must be added. Thinness may be corrected by adding more indiarubber. A piece of solid rubber no larger than a walnut will make a pint of the cement. It dries in a few minutes, and, by using 3 coats in the usual manner, leather straps, patches, rubber soles, backs of books, &c., may be joined with great firmness. (5) Indiarubber, 8 gr.; chloroform, 600 gr.; mastic resin, 150 gr. The indiarubber is dissolved in the chloroform, the mastic is added, and the whole is left to macerate for 8 days, that being the time necessary for the solution of the mastic. The cement is applied cold on a brush, and is used for joining glass. (6) Very finely-divided indiarubber is melted at a temperature of 392° F. (200° C.). As soon as fusion commences, $\frac{1}{15}$ the quantity of tallow or wax is added, taking care to watch the heat and to stir without ceasing. When the mass is completely melted, lime, slaked and sifted, is added in small instalments, till it amounts to half the quantity of the indiarubber. The cement thus obtained is soft; if the proportion of lime be doubled, the cement will be harder, but still supple. When the compound has acquired a suitable consistence, the fire is withdrawn, and the preparation is finished. This forms a good cement for hermetically sealing vessels. It does not dry, and remains for a long time ductile and tenacious; but it may be made to harden if necessary, by adding 1 part of red lead to the quantities indicated.

(7) For Vulcanized Rubber. Oil and sulphur: 1 of sulphur to 12 of oil gives a substance like treacle; 4 to 12 of oil a stiff substance like rubber. To be successful in making this compound, take an iron ladle, such as is used for the melting of lead, and fill it not more than $\frac{1}{3}$ full, and place it over a clear fire. Owing to a quantity of water being held in the oil by the vegetable matter, it will begin to seethe, and, if not closely watched, boil over into the fire. After a little time it will subside, the surface remaining quite placid, with now and then little flickers of smoke flitting across the surface. Your sulphur must be either roll brimstone or the crude sublimed, i. e. not washed or treated with acid. If the first, finely powder it, and mix by degrees in the oil, stirring all the time until incorporated. (8) Guttapercha. To make guttapercha cement, melt together in an iron pan 2 parts of common pitch and 1 of guttapercha; stir them well together until thoroughly incorporated, and then pour the liquid into cold water. When cold it is black, solid, and elastic; but it softens with heat, and at 100° F. (38° C.) is a thin fluid. It may be used as a soft paste, or in a liquid state, and answers an excellent purpose in cementing metal, glass, porcelain, ivory, &c. It may be used instead of putty in glazing windows.

Iron.—Iron filings or borings, when mixed with sulphur, sal ammoniac, &c., expand and form a compact mass which makes a very firm steam-tight joint if properly applied. Concerning this cement, Dr. Ure says: The iron rust cement is made of 50 to 100 parts of iron borings, pounded and sifted, mixed with 1 part of sal ammoniac, and when it is to be applied, moistened with as much water as will give it a pasty consistence. Formerly, flowers of sulphur were used, and much more sal ammoniac in making this cement, but with decided disadvantage, as the union is effected by oxidation, and the consequent expansion and solidification of the iron powder, and any heterogeneous matter obstructs the effect. The best proportion of sal ammoniac is 1 per cent. of the iron borings. (2) Mix 4 parts of fine borings or filings of iron, 2 of potter's clay, and 1 of powdered firebrick, and make them into a paste with salt and water. When this cement is allowed to concrete slowly on iron joints, it becomes very hard. (3) Coarsely powdered iron borings, 5 lb.; powdered sal ammoniac, 2 oz.; sulphur, 1 oz.; and water sufficient to moisten it. This composition hardens rapidly; but if time can be allowed, it sets more firmly without the sulphur. It must be used as soon as mixed, and rammed tightly into the joints. (4) Sal ammoniac, 2 oz.; sublimed sulphur, 1 oz.; cast-iron filings or fine turnings, 1 lb. Mix in a mortar and keep the powder dry. When it is to be used, mix it with 20 times its weight of clean iron turnings or filings, and grind the whole in a mortar; then wet it with water until it becomes of convenient consistence, when it is to be applied to the joint. After a time it becomes as hard and strong as any part of the metal. (5) The following is said to form a very hard cement: Take a few spoonfuls of iron filings, and oxide of iron in the form of black scales which fall from red-hot bars of iron in blacksmiths' shops: crush them fine with a hammer, mingle with the powder an equal bulk of the best Portland cement, and render the mass plastic by adding the white of eggs, and work for a few minutes, until the plastic material is about of the consistence of soft putty. Only a small quantity should be prepared at once, as it will set in a short time. (6) A correspondent of the *English Mechanic* says that he has used the following recipe with the greatest success for the cementing of iron railing tops, iron gratings to stoves, &c., and with such effect as to resist the blows of the sledge hammer:—Take equal parts of sulphur and white lead, with about a sixth of borax, incorporate them so as to form one homogeneous mass. When going to apply it, wet it with strong sulphuric acid, and place a thin layer of it between the two pieces of iron, which should then be pressed together. In 5 days it will be perfectly dry, all traces of the cement having vanished, and the iron will have the appearance of having been welded together. (7) 5 parts sulphur, 2 of graphite, and 2 of fine iron filings are melted together, taking care that the sulphur does not catch fire. The parts, previously warmed, are covered with the cement, reduced to a pasty consistence on a fire, and firmly pressed together. This cement, it is said, is very well adapted to fill out leaks in cast-iron vessels. (8) For Hot-Air Pipes. 60 parts (by measure) of chalk, 20 of limestone or lime, 20 of salt, 10 of brawsey sand, 5 iron filings, and 5 of red or blue clay, properly mixed together, triturated, and calcined. (9) For Hot-Water Cistern. To 4 or 5 parts clay dried and pulverized, add 2 of fine iron filings free from oxide, 1 of peroxide of manganese, ½ of sea-salt, and ½ of borax. Thoroughly incorporate these in as fine a state as possible, reduce them to a thick paste with water, and use immediately. It should then be exposed to a heat, gradually increasing to almost a white heat. This cement resists heat and boiling water. (10) Glycerine and litharge, stirred to a paste, harden rapidly, and make a tolerable cement for iron upon iron, for two stone surfaces, and especially for fastening iron in stone. This cement is insoluble, and is not acted upon by strong acids. (11) You can cement cloth to polished iron shafts by first giving them a coat of best white-lead paint; this being dried hard, coat with best Russian glue, dissolved in water containing a little vinegar or acetic acid. (12) For Iron and Glass. Copal varnish 15 parts, drying oil 5, turpentine 3, oil of turpentine 2, liquefied glue 5; to be all melted in a water-bath, and add 10 parts of slaked lime. (13) For cast-iron cisterns of large dimensions: composed of sal ammoniac, clean borings, and urine, mixed one day before required. The proportions are 1 lb. sal ammoniac to 100 lb. borings, with sufficient urine to make a stiff paste—to be well driven into the joints with a caulking tool a little narrower than the space between the flanges. Give at least 3 days to set before filling cistern with water. The cement sets as hard as the metal itself. (14) Iron borings, 12 lb.; sal ammoniac, 2 oz.; sulphur 1 oz.; water q.s. (15) Iron borings 7 to 8 lb., sal ammoniac, 2 oz., water as before. The strongest lute, perhaps, is (15); but when the work is required to dry rapidly, as in the case of steam joints wanted in a hurry, the quantity of sal ammoniac must be slightly increased, and a very little sulphur must be added. This addition causes quicker setting, but reduces the strength. The power of these lutes is dependent upon the oxidation and consequent expansion of the mass, therefore the less foreign matters they contain, the better. They should be made up only as they are required, as they spoil rapidly; when containing much sulphur, they may become quite hot in a few hours, and combustion has been known to take place in them when left together in quantity for a night. (16) Finely sifted iron filings, 60 parts; finely powdered sal ammoniac, 2 parts; flowers of sulphur, 1 part. This powder is made into a paste with water, and immediately applied; it soon sets as hard as the iron it is intended to lute. (17) For iron pots and pans. 2 parts sulphur, 1 of graphite; the sulphur is held in an old iron pan over the fire till it begins to melt; the graphite is then added, and the mass well stirred till thoroughly melted and combined; then poured out on an iron plate or smooth stone, and broken up when cold. Used like solder with a soldering iron. Holes should first be filled with a rivet, and then cemented over.

Isinglass.—This is probably the purest form of gelatine or animal glue, and it makes one of the strongest cements known. As a cement, it may be treated like glue. From the fact that it is made from the sounds of fishes, it is sometimes called fish-glue.

Ivory.—The American or Diamond cement unites pieces of ivory with great firmness, but where a white cement, of nearly the same colour as ivory is required, the following modification will be found useful: (1) Dissolve 1 part of isinglass and 2 of white glue in 30 of water; strain and evaporate to 6 parts, then add $\frac{1}{30}$ part of gum mastic, dissolved in ½ part of alcohol, and add 1 part of zinc white. When required for use, warm and shake well. The broken edges to be joined must also be warmed.

Japanese.—This is simply a paste made of fine rice flour, well boiled and ground in a mortar.

Jewellers'.—It sometimes happens that jewellers, in setting precious stones, break off pieces by accident; in this case they unite the parts so that the joint cannot be easily seen, with gum mastic, the stone being previously made hot enough to melt it. By the same medium, cameos of white enamel or coloured glass are often joined to a real stone as a ground, to produce the appearance of an onyx. Mastic is likewise used to cement false backs or doublets to stones, to alter their hue. (Ure.) The term *Jewellers' Cement* is also applied to *Armenian Cement*, which see. (1) Shellac, melted and run into sticks as large as quills. Used for joining glass, earthenware, &c.; the edges are heated sufficiently to melt the cement, which is then applied, and the joint is made while the heat lasts. (2) Tears of gum mastic employed in the same way. (3) Shellac, 2 parts, Venice turpentine, 1 part; fused together and formed into sticks. Used as the preceding.

Kerosene Lamps.—The cement commonly used for fastening the tops on kerosene lamps is plaster-of-Paris, which is porous, quickly penetrated by the kerosene, and soon destroyed. Another cement which has not this defect is made by boiling 3 parts of resin, and 1 of caustic soda in 5 of water. This composition forms a soap, which, when mixed with half its weight of plaster-of-Paris, sets firmly in about ¾ hour. It is said to be of great adhesive power, not permeable by kerosene, a low conductor of heat, and but superficially attacked by hot water.

Labels.—(1) The usual adhesive coating for "gum tickets," is the cheaper varieties of gum arabic dissolved in water, applied with a brush and dried. (2) Mix dextrine with water, and add a drop or two of glycerine. (3) Labels that are exposed to acid fumes or damp, may be attached with any good paste, and when dry, coated with copal varnish. If neatly done, the appearance is very good, and moisture and acids have no action on them. (4) For attaching labels to tin and other bright metallic surfaces, first rub the surface with a mixture of muriatic acid and alcohol; then apply the label with a very thin coating of the paste, and it will adhere almost as well as on glass. (5) To make cement for attaching labels to metals, take 10 parts tragacanth mucilage, 10 of honey, and 1 of flour. The flour appears to hasten the drying, and renders it less susceptible to damp. (6) Another cement that will resist the damp still better, but will not adhere if the surface is greasy, is made by boiling together 2 parts of shellac, 1 of borax, and 16 of water. (7) Flour paste to which a certain proportion of nitric acid has been added, and heat applied, makes a lasting cement, but the acid often acts upon the metals. The acid converts some of the starch into dextrine. (8) Dissolve 2 dr. isinglass in 4 oz. distilled vinegar; add as much gum arabic as will give it the required consistency. This mucilage keeps very well, but is apt to become thinner, when a little more gum may be added. (9) Dissolve isinglass in vinegar to a pretty thick consistence when warm. This congeals on cooling, and before it is used should be gently warmed. (10) A capital adhesive liquid for sticking tickets on glass, wood, or paper, is obtained as follows: About ¼ oz. fine glue which has been a day before soaked in water, and some candy sugar, with ½ oz. gum arabic, and 3 oz. water, are placed in a small bowl over a spirit lamp, and continually stirred till the composition thoroughly boils and dissolves, and the mass becomes thin. When coated with this cement and then dried, the tickets, when moistened with the tongue, will stick with the greatest tenacity. (11) Dextrine, 2 parts; acetic acid, 1; water, 5; dissolve in a water-bath and add 1 part of alcohol. Forms an excellent mucilage for stamps and labels that are to be kept ready gummed. (12) It is said that for the labels of seltzer or soda water bottles, the best paste is one made of good rye flour and glue, to which linseed oil varnish and turpentine have been added in the proportion of ½ oz. of each to the lb. The paste must be made quite hot, and the oil incorporated with it by thorough heating. Labels attached by this cement do not fall off in damp cellars. (13) Soften good glue in water; then boil it with strong vinegar, and thicken the liquid, during boiling, with fine wheat-flour, so that a paste results. (14) Starch-paste, with which a little Venice turpentine has been incorporated while it was warm. (15) Paint solution of tannin over the spot, let dry, and then affix the label previously gummed and moistened. (16) Corrosive sublimate, 125 parts; wheaten flour, 1000 parts; absinthe, 500 parts; tansy, 500 parts; water, 15,000 parts. This cement is useful for vessels which are kept in a damp place; the addition of the sublimate retards the destruction of the labels. (17) Starch, 100 parts; strong glue, 50 parts; turpentine, 50 parts; the whole boiled in water. This cement dries quickly. (18) Best red sealing-wax ½ oz., spirits of wine 2 dr., and from 5 to 10 drops of muriate of tin; let stand for 36 hours, and stir with a glass rod before using. This answers for making nearly everything adhere to tin articles. (19) Leather to polished zinc. Nothing better than glue, made in the ordinary manner, but rather thin, to which is added its own bulk of Beaufoy's acetic acid. (20) T. A. Richardson, the architect, recommends to every 2 tablespoonfuls of the best wheaten flour to add a teaspoonful of common moist or brown sugar, and a little corrosive sublimate; the whole to be boiled, and continually stirred to prevent getting lumpy, till of the right thickness. To stop mouldiness, a few drops of some essential oil, as lavender or peppermint. This paste is used to make different thicknesses of cardboard. In putting or jointing together, he recommends 6 oz. gum arabic (best), 1 oz. or less of moist or lump sugar, 1 teaspoonful of lavender or other essential oil, and a tablespoonful of gin—the whole to be mixed in cold water to the consistency of a thick syrup, no heat being in any way applied. (21) Dissolve 180 gr. of best French glue in 180 gr. of water by soaking and heating. Then add a solution of 1 gr. of shellac in 6 gr. of alcohol, and stir well as long as the solution is warm. Mix also 35 gr. of dextrine in 50 gr. of alcohol and 25 gr. of water, stir it well in a beaker and place it into warm water until the solution is completed and has acquired a clear brown colour. Mix this solution with that of the glue, and pour the whole into a suitable form in which it may solidify. When wanted for use, cut off a small piece and liquefy it by warming.

Laboratory. — Equal parts of pitch, rosin, and plaster-of-Paris united by fusion. Used for lining casks for holding chloride of lime, and for joining and coating the masonry of acid chambers, &c.

Lead.—(1) Simply pure white lead ground in oil, and used very thick, is an excellent cement for mending broken crockery ware; but it takes a very long time to harden sufficiently. The best plan is to place the mended object in some store-room, and not to look after it for several weeks, or even months. After that time it will be found so firmly united that, if ever again broken, it will not part on the line of the former fracture. It resists moisture, and a heat not exceeding that of boiling water. (2) White lead, ground in oil, a sufficient quantity; add dry red lead enough to make a stiff putty. Put the mass in a mortar or on a block of iron or smooth stone, and pound it till it becomes soft; continue to add red lead, and pound until the mass will no longer become softer by pounding, nor stick to the fingers. At this time it should be of sufficient tenacity to stretch out 3 or 4 in. when pulled, without parting. The more protracted the pounding, the softer, finer, and more tenacious the cement becomes. Interpose this putty between the flanges of steam-pipe joints, taking care to put a thin grummet of packing or wicking around the diameter of the bore, to keep the cement from squeezing through when the flanges are screwed together. It is indestructible by steam or water, and makes the best joint known to the engineer. (3) Mix 2 parts finely powdered litharge with 1 of very fine sand, and 1 of quicklime which has been allowed to slake spontaneously by exposure to the air. This mixture may be kept for any length of time without injuring. In using it, a portion is mixed into paste with linseed oil, or, still better, boiled linseed oil. In this state it must be quickly applied, as it soon becomes hard. (4) Mohr's. Equal parts litharge and brickdust made into a paste with linseed oil, applied, and a little sand dusted over. (5) Serbat's. Sulphate of lead calcined and ground, 72 parts; peroxide of manganese, 24 parts; linseed oil, 13 parts; intimately mixed. This lute is soft, and will remain in that state indefinitely. For use, it only needs to be rubbed up between the hands. It may be advantageously employed in boilers, steam engines, &c.; it sets perfectly, and does not soften under the influence of heat, but, on the contrary, becomes very hard, especially if care be taken to pass a hot iron over the joints. A sudden leak may be stopped immediately, by applying some of this lute under a hot iron. It is preferable to red lead.

Leather.—(1) One says, that after an experience of 15 years he has found nothing to equal the following: Common glue and isinglass, equal parts, soaked for 10 hours in just enough water to cover them. Bring gradually to a boiling heat, and add pure tannin until the whole becomes ropy, or appears like the white of eggs. Buff off the surfaces to be joined, apply this cement warm, and clamp firmly. (2) Mix 10 parts bisulphide of carbon with 1 of oil of turpentine, and then add enough guttapercha to make a tough thickly-flowing liquid. One essential pre-requisite to a thorough union of the parts consists in freedom of the surfaces to be joined from grease. This may be attained by laying a cloth upon them and applying a hot iron for a time. The cement is then applied to both pieces, the surfaces brought into contact, and pressure applied until the joint is dry. (3) Another leather cement is made of guttapercha dissolved in bisulphide of carbon, the mixture being about the thickness of syrup; the parts to be cemented must be well coated, so as to fill the pores of the leather; then heat the cement and join the ends, hammering the parts until the cement is cold. (4) To cement leather to metal: Wash the metal with hot gelatine; steep the leather in an infusion of nut galls (hot), and bring the two together. (5) 1 lb. guttapercha, 4 oz. indiarubber, 2 oz. pitch, 1 oz. shellac, 2 oz. linseed oil; melted together; it hardens by keeping, and needs remelting for use. (6) Leather to metal: (*a*) melt together equal parts asphalt and guttapercha, and apply hot under a press. (*b*) F. Sieburger recommends the following process by Fuchs. Digest 1 part crushed nutgalls with 8 distilled water for 6 hours, and strain; macerate glue with its own weight of water for 24 hours, and dissolve; spread the warm infusion of the galls on the leather, and the glue on the roughened metallic surface; apply the prepared surfaces together, and dry gently; the leather then adheres so firmly to the metal that it cannot be removed without tearing. (*Polyt. Notizblatt.*) (7) Leather to Pasteboard. Strong glue, 50 parts, is dissolved with a little turpentine in a sufficiency of water, over a gentle fire; to the mixture is added a thick paste made with 100 parts of starch. It is applied cold, and dries rapidly.

Mahogany.—The following lutes are used to stop holes and cracks in mahogany furniture:—(1) Beeswax, 4 oz.; melt and add Indian red, 1 oz.; and enough yellow ochre to produce the required tint. (2) Shellac melted and coloured as above, very hard.

Marble.—(1) *Keene's.* Baked gypsum or plaster-of-Paris, steeped in a saturated solution of alum, and then recalcined and reduced to powder. For use it is mixed up with water as ordinary plaster-of-Paris. This preparation forms a stucco, rather than a cement. It takes a high polish, and when coloured is very beautiful, but does not unite pieces as strongly as: (2) An excellent cement for mending marble or any kind of stone, is made by mixing 20 parts of litharge and 1 of freshly burned lime in fine dry powder. This is made into a putty by linseed oil. It sets in a few hours, having the appearance of light stone. (3) Resin, 8 parts; wax, 1; plaster-of-Paris, 4; mix by fusion. The pieces to be joined must be made hot. (4) Lac coloured to imitate the marble; may be mixed with marble dust passed through a silken sieve. (5) W. F. Reid gives the following details for it. Begin with the raw gypsum in lumps of moderate size, burning them at the usual temperature (below red heat). The solution of alum should contain 1 part of this salt in 10 of water. There is no difficulty in dissolving this quantity if the water be previously heated and the alum coarsely pulverized. By immersing the lumps of burnt gypsum in this solution while they are still warm, and leaving them in it for about 15 minutes, they will become thoroughly saturated with the liquid. They should then be allowed to drain and again burnt, but this time at a red heat. Gypsum which has been treated in this way forms, when pulverized, a slow-setting cement which ultimately attains great hardness, and has frequently been used for making paving tiles, especially in Italy. (6) Into a solution of chloride of zinc, sp. gr. 1·490 to 1·652, is introduced 3 per cent. of borax or sal ammoniac; when this is dissolved, oxide of zinc, which has been subjected to a red heat, is added, till the mass attains the desired consistence. This cement becomes as hard as marble, and may be used for moulding. (7) 12 parts Portland cement, 6 slaked lime, 6 fine sand, 1 infusorial earth, and mix into a thick paste with silicate of soda. The object to be cemented need not be warmed. The cement sets in 24 hours, and the fracture can then hardly be detected. The cemented portions are harder than the rest, and the fracture cannot by any chance be reopened. (*Polytech. Centralblatt.*)

Marine Glue.—Marine glue is probably the strongest cement known, and when well made and properly applied, it is capable of uniting wood, metal, glass, leather, &c., with a strength and durability that is astonishing. It is a combination of shellac and indiarubber in proportions which vary according to the purposes for which the cement is to be used. Some is very hard, some quite soft. The degree of softness is also regulated by the proportion of naphtha used for dissolving the indiarubber and shellac. It is difficult to prepare it on the small scale. The following is the formula for the ordinary variety:—(1) Indiarubber (cut small), 1 part; coal-tar naphtha, 12; digest in a covered vessel with heat and agitation, and when the solution is complete, add of powdered shellac, 20 parts. Continue the heat and stirring until perfect liquefaction has taken place, and pour the fused mass, whilst still hot, on slabs of polished metal or stone so as to form thin sheets. When used it is to be heated to its melting-point, 248° to 250° F. (120° to 121° C.), in an iron vessel, and applied in the liquid state with a brush. Great care and considerable experience are necessary to enable any one to use this cement. If the solid cement be heated but a very few degrees above its melting-point, it crumbles and becomes useless. One may succeed by cutting it in shreds, placing these between the parts to be joined, and heating the whole until the glue can be pressed into uniform contact with the entire surfaces. Sometimes it is convenient to use a form of the glue which is more fluid, from containing more naphtha. The following formulæ answer in such cases, but are not as strong as the ordinary marine glue. (2) Dissolve 3 parts shellac, and 1 of indiarubber, in separate vessels, in ether free from alcohol, applying a gentle heat. When thoroughly dissolved, mix the two solutions. Use rectified sulphuric ether that has been washed to remove alcohol and acidity, and indiarubber that has not been vulcanized. When the indiarubber has become well softened by the ether, break it up into small pieces, and stir well until a homogeneous soft mass is obtained. It will be as well to cut the rubber into small pieces before pouring the ether on, but the mass must be frequently and well stirred. Pour the solution of shellac into that of the rubber, and incorporate them thoroughly by stirring. This is a modification of the famous marine glue, and resists the action of water, both hot and cold, and most of the acids and alkalies. If the glue be thinned by the admixture of ether, and applied as a varnish to leather, along the seams where it is sewed together, it renders the joint or seam water-tight, and almost impossible to separate. (3) The following recipe, taken from *New Remedies*, is said to yield a strong cement: 10 parts of indiarubber are dissolved in 120 of benzine or petroleum (?) naphtha with the aid of a gentle heat. When the solution is complete, which sometimes requires 10 to 14 days, 20 parts of asphalt are melted in an iron vessel, and the indiarubber solution is poured in very slowly, in a fine stream, and under continued heating, until the mass has become homogeneous, and nearly all of the solvent has been driven off. It is then poured out and cast into greased tin moulds. It forms dark-brown or black cakes, which are very hard to break. This cement requires considerable heat to melt it; and to prevent it from being burnt, it is best to heat a capsule containing a piece of it first on a water-bath, until the cake softens and begins to be liquid. It is then carefully wiped dry, and heated over a naked flame, under constant stirring, up to about 300° F. (149° C.). The edges of the article to be mended should, if possible, also be heated to at least 212° F. (100° C.), so as to permit the cement to be applied at leisure and with care. The thinner the cement is applied, the better it binds. (4) Indiarubber, 15 to 20 gr.; chloroform, 2 fl. oz.; dissolved; powdered mastic, $\frac{1}{2}$ oz., is added. The cement must be kept well corked, and in a cool place, to prevent loss by evaporation. (5) Finely divided indiarubber, 1 part, is dissolved in naphtha oil, or crude naphtha, 40 parts. The solution is not completed in less than 10 or 12 days, and, in order to facilitate it, the mixture should be repeatedly agitated. To it, is then added gum lac, in the proportion of 2 parts by weight of lac to 1 of solution. The compound is then placed in an iron vessel over a fire, and constantly thinned till it becomes homogeneous. It is then poured on a cold surface, such as a slab of marble or a flag-stone, and left till cool, when it is broken up and put by for use. The indiarubber is sometimes omitted, in which case, the proportions will be 1 part of naphtha and 2 of lac. When required for use, the cement is heated at a temperature not exceeding 212° to 230° F. (100° to 110° C.), in a thick vessel of copper or cast iron, and is brushed in thin and even layers on the surfaces to be joined; these are then brought into close contact, and strongly pressed. If the surfaces are so wide that the cement becomes cool before the operation is finished, it is well to pass a hot iron—say at about 140° F. (60° C.)—over it. It is valuable, not only for repairing broken wood, but also for cementing the moulds used in foundries, for caulking ships, for joining blocks of marble or granite, and for uniting wood and iron. It can be made as hard as desired, by increasing the proportion of lac. With the addition of bichloride of mercury dissolved in wood spirit, this cement might, with economy, replace the copper sheathing of ships. Wood, iron, plaster, and brick, to which it is applied, assume a varnished appearance; timber is rendered free from the attacks of insects and from liability to rot, and iron is preserved from rust.

Masons'.—(1) 20 lb. clean river sand, 2 lb. litharge, 1 lb. quicklime, sufficient linseed oil to form a thin paste. Used for joining fragments of stone. (2) Gad's. 3 parts well-dried and powdered clay, 1 of iron oxide, mixed together and made into a stiff paste with boiled oil. Used for work required to harden under water. (3) For grotto work. Commonest sealing-wax. (4) An excellent cement for foot-walks, and for all uses which require exposure to the weather or to dampness, is described in 'Der Praktische Maschinen-Constructeur.' It is made by thoroughly stirring Portland cement or good hydraulic lime into a warm solution of glue, so as to make a thick paste, and applying it immediately. In three days it acquires extraordinary hardness and tenacity. It is an excellent cement for joining the porcelain heads to the metal spikes which are used as ornamental nails. (5) Fahnejelm recommends a mixture of 75 parts of carefully washed chalk and 25 parts of washed kaolin, to be first calcined to red heat, and afterwards ground. The powder is then snow-white, or, if the heat has been too great, it has a bluish shade. Either alone, or with a small percentage of gypsum, it makes an excellent hydraulic cement. (6) 1 part yellow Botany Bay gum, 1 of brickdust, melted together. For stoneware. (7) 60 parts chalk, 20 of lime, 20 of salt, 10 of Barnsey sand, 5 of iron filings, 5 of clay; ground together, and calcined. Beale's. (8) 3 parts clay, 1 of slaked lime; mixed, exposed for 3 hours to full red heat, and ground to powder. Bruyere's hydraulic.

Meerschaum.—(1) The best cement for joining pieces of meerschaum, is *Egg Cement*, which see. (2) Garlic, crushed to form a sort of dough, is rubbed over the surfaces of the meerschaum to be united; the latter are then bound tightly together with fine wire, and boiled in milk for half an hour. (3) Quicklime is mixed to a thick cream with the white of an egg. These cements will also join fragments of glass or china.

Metal to Glass, Stone, &c.—For attaching metal plates, such as letters, &c., to flat sheets of glass, the following may be used:—(1) Copal varnish, 15; drying oil, 5; turpentine, 3. Melt in a water-bath and add 10 parts slaked lime. (2) Copal varnish, 15 parts; boiled linseed oil, 5; Venice turpentine, 5; glue, melted in the smallest possible quantity of water, 5 parts. Melt together and add 10 parts of powdered quicklime. (3) Carpenters' glue, 4 parts; Venice turpentine, 1. (4) Rosin is melted, and into it is stirred calcined plaster till the mass is reduced to a paste, to which is added boiled oil, in sufficient quantity to bring it to the consistence of honey. It is applied warm. (5) Into melted rosin, 180 parts, are stirred burnt umber, 30 parts; calcined plaster, 15 parts; boiled oil, 8 parts. (6) Rosin, 4 to 5 parts; wax, 1 part; colcothar, 1 part; the whole melted together. A little powdered plaster is often added. (7) Sandarac or [illegible] 15 [illegible]

turpentine, 2½ parts; [illegible] parts; pearl white, 5 parts; dry carbonate of lead, 5 parts; mixed. (8) Copal or lac varnish, 15 parts; drying oil, 5 parts; indiarubber or guttapercha, 4 parts; coal oil, 7 parts; Roman cement, 5 parts; plaster, 5 parts. (9) Copal or rosin varnish, 15 parts; turpentine, 2½ parts; essence of turpentine, 2½ parts; fish isinglass, in powder, 2 parts; iron filings, 3 parts; ochre or rottenstone, 10 parts. These cements are much used for fixing metallic letters to glass, marble, or wood. The two following are particularly good for uniting brass and glass:—(10) Caustic soda, 1 part; rosin, 3 parts; plaster, 3 parts; water, 5 parts; the whole is boiled. This compound hardens at the end of half an hour; the hardening may be retarded by replacing the plaster by zinc white, white lead, or slaked lime. (11) Fine litharge, 2 parts; white lead, 1 part; copal, 1 part; boiled linseed oil, 3 parts; the whole is triturated together. (12) For joining metallic surfaces where soldering is inconvenient, recourse may be had to a composition formed in the following way:—Pure and finely divided copper, such as that obtained by the reduction of sulphate of copper with zinc clippings, 20 to 36 parts, according to the degree of hardness desired in the cement, dissolved in a sufficient quantity of sulphuric acid to make a thick paste; with this is incorporated, by trituration in a mortar, mercury, 70 parts. The mass is soft, but hardens at the end of some hours. For use, it is heated to 212° F. (100° C.), and powdered in an iron mortar heated to 302° F. (150° C.); it then assumes the consistence of wax, and is harder in proportion as it contains more copper. It adheres strongly on drying. (13) To obtain a cement suitable for joining metals and non-metallic substances, mix liquid glue with a sufficient quantity of wood-ashes to form a thick mass. The ashes should be added in small quantities to the glue while boiling, and constantly stirred. A sort of mastic is thus obtained, which, applied hot to the two surfaces that are to be joined, makes them adhere firmly together. (14) A similar substance may be prepared by dissolving in boiling water 2¼ lb. of glue and 2 oz. of gum ammoniacum, adding, in small quantities, about 2 oz. of sulphuric acid.

Microscopical.—Dr. H. Wood describes a new cement invented by Dr. J. G. Hunt, which seems likely to be generally useful, and in some cases extremely valuable. It is prepared as follows:—Take dammar gum, any quantity, and dissolve it in benzole; after obtaining a solution just thick enough to drop readily from the brush, add enough of the finest dry oxide of zinc previously triturated in a mortar with a small quantity of benzole, until the solution becomes white when thoroughly stirred. If not too much zinc has been added, the solution will drop quickly from the brush, flow readily, and dry quick enough for convenient work. It will adhere, if worked properly, when the cell cover is pressed down, even when glycerine is used for the preservative medium; keep in an alcohol-lamp bottle with a tight lid and secure the brush for applying the cement in the lid of the bottle. Its advantages lie in the circumstance that the glass cover can be placed upon the ring of it whilst still fresh and soft, and that in drying it adheres to both cover and slide, so as to form a joint between them of the width of the ring of cement, and not, as with asphaltum, gold-size, &c., simply at the edge and upon the outside of the cover. The method of mounting with it is as follows:—A ring of any desired size is made by means of an ordinary Shadbolt's turntable, upon a slide, which is then placed to one side to dry; when required for use, the specimen, cover, &c., being all prepared and ready, the slide is again placed upon the turntable, and a new ring of cement put directly upon the old one. The specimen is immediately placed within the cell thus formed, and the requisite quantity of carbolated water placed upon it. The cover, which must be large enough to entirely or nearly cover the cement ring, is now picked up with the forceps, the under side being moistened by the breath to prevent adhesion of air-bubbles, and carefully placed in position. It is now to be carefully and equably pressed down with some force; by this any superfluous water is squeezed out, and the cover is forced down into the cement, which rises as a little ring around its edge. The pressure is best made with a stiff needle, at first on the centre, and then upon the edges of the cover, which may finally be made slowly to revolve beneath the needle point. The slide may then be put aside to dry; or, better, an outside ring of the cement put over its edge in the usual way. If time be an object, and only a shallow cell be required, the first ring of cement may be dispensed with, and the whole mounting be done in a few minutes.

Milk.—This cement is not so generally known as it ought to be. It is the simplest and best domestic cement for repairing china and crockery. The process consists simply in tying the parts firmly together and boiling them in skimmed milk. The tying together of the pieces of a round cup or bowl is not a very simple matter, but it can be done by going the right way to work. First, arrange the parts in their proper positions, and, if a bowl, set it mouth down, as the pieces will keep their arrangement best in this position. Then wind stout tape round the article, so as to hold the pieces together. Tape is far better than twine, and pieces should be kept for this purpose. It is easy to draw the tape tight until we come to tie the ends, and then special devices must be used. When sufficient tape has been wound round the article, let one person hold it from slipping, by pressing a finger firmly on each end, and then let another person tie the ends in a firm knot, but leaving the tape so loose from the article that a pencil or stout skewer may be passed under it. Then by twisting the skewer the tape is tightened in the same way that a surgeon compresses an artery with his tourniquet, and by passing the fingers over the tape, and smoothing it forward toward the ends, all the pieces may be pressed together with a firmness that cannot be obtained in any other way. The article should now be placed in a pan of cold milk (skim-milk is the best and cheapest), which should be gradually heated to the boiling-point, and kept at this temperature for some time—say ½ to 1 hour—care being taken not to allow it to burn. The articles are allowed to cool in the milk, and when taken out are wiped dry and allowed to stand for a day or two until the cement has become quite hard. They may then be washed off with warm water, and the parts will be found to be strongly cemented together. The same milk may be used again, but not with such good effect. Generally, however, it is possible to pack quite a number of articles in the pan in the first place, especially if they can be "nested," or placed one within the other.

Naturalists'. — Consists of mucilage of gum arabic, thickened with starch powder or farina, with the addition of a little lemon-juice. Sometimes the mucilage is used alone. This cement is employed by naturalists, for mounting specimens; by artificial flower makers; by confectioners, to stick ornaments on their cakes, &c.

Opticians'.—The cements obtained from the following formulæ are used by opticians for fixing lenses, prisms, &c., to chucks and holders, while they are being ground. (1) Pitch, 5 parts; wood ashes, 1; tallow, 1, less or more, according to the temperature of the season. (2) Shellac softened with rectified spirit or wood naphtha. (3) Beeswax, 1 oz.; resin, 15 oz.; melt and add 5 oz. of whiting previously heated red hot and still warm. (4) Resin, 1 lb.; melt and add dry and warm plaster 4 oz. This forms a very strong cement for rough purposes.

Parabolic.—This is a variety of casein or cheese cement, prepared as follows: Curdle skim-milk with rennet or vinegar, press out the whey, and dry the curd by a very gentle heat, but as quickly as possible. When quite dry, grind it in a pepper or coffee mill, and triturate it in a mortar until reduced to a very fine powder. Mix 10 parts by weight of this powder with 1 of quicklime, also in very fine powder, and to every ounce of the mixture add 5 or 6 gr. of camphor. Triturate the whole together, and keep in phials well corked. Used to unite glass, earthenware, &c., which it does very strongly. It is made into a paste with a little water as wanted, and applied immediately. See *Casein.*

Parian.—Same as Keene's marble cement (see *Marble*), substituting a solution of borax for one of alum.

Paris.—This cement is used for mending shells and other specimens of natural history. It is composed of gum arabic 5; sugar candy, 2; white lead, enough to colour.

Paste.—Next to glue, paste is the most extensively used, and the most valuable cement that we have. For ordinary purposes it consists simply of flour, made into a thin cream with water, and boiled. It then forms a stiffish mass, which may be diluted with water so as to bring it to any required condition of thickness. There are two distinct elements in flour, both of which are valuable, one is starch, and the other is gluten. The cheaper kinds of flour, and especially rye flour, are rich in gluten, while wheat flour is rich in starch. In the latter case, it is sometimes of advantage to add a little common glue to the paste. For ordinary purposes no additions are necessary, but where paste is to be kept for a long time, various ingredients may be added, to prevent souring and moulding. A few cloves form, perhaps, the best preservative for small quantities. On the larger scale carbolic acid may be used. If it were not for the expense, salicylic acid would form a good preservative. According to the statement of Lunge, souring and moulding may be entirely prevented by the addition and thorough mixture with the freshly-prepared paste of a few gr. of salicylic acid. When thus treated, a paste may be kept for weeks in a heated room without losing its freshness, and even when it has, by long standing, become dry and tough, may be at once rendered fluid and serviceable by treatment with hot water. The addition of the acid does not, according to this author, affect the stickiness of the paste to any sensible degree. When it is desired to prevent the attacks of insects, either before or after use, the addition of corrosive sublimate is a sure preservative, but as this substance is a powerful poison, great care must be exercised when it is employed. The following formulæ give good results:—

(1) *Starch Paste.*—This is best prepared by triturating the starch with cold water in a mortar until no lumps remain, and not too thick a mass is formed, and pouring into this boiling water very slowly, with rapid stirring, until the paste begins to form, as indicated by the increase of transparency, and then rapidly adding the rest of the boiling water necessary for the paste. Boiling the paste is very injurious, rendering it less adhesive, and liable to peel off. Rye flour affords a more adhesive paste than starch, but of a grey colour. The addition of a little alum to the water with which paste is prepared renders it more permanent, and the use of boiling lime-water instead of pure water adds to its adhesiveness. An aqueous extract of decomposed gluten, however, affords the best paste with starch. By incorporating with the paste a quantity of turpentine, equal in weight to half of the starch employed, and stirring well while the paste is still hot, it will be rendered more impervious to moisture, and at the same time more adhesive.

(2) *Corn Starch Paste.*—Corn starch makes a good paste for scrap-books. Dissolve a small quantity in cold water, then cook it thoroughly. Be careful and not get it too thick. When cold it should be thin enough to apply with a brush. It is not so liable to mould and stain the paper as paste made from other kinds of starch.

(3) *Paste for Mounting Photographs.*—Mix thoroughly 630 gr. of the finest Bermuda arrowroot with 375 gr. of cold water in a capsule, with a spoon or brush; then add $10\frac{1}{2}$ oz. of water and 60 gr. of gelatine in fine shreds. Boil, with stirring, for 5 minutes, or until the liquid becomes clear, and when cold stir in well 375 gr. of alcohol, and 5 or 6 drops of pure carbolic acid. Keep in well-closed vessels, and, before using it, work up a portion with a brush in a dish.

(4) 4 parts, by weight, of glue are allowed to soften in 15 parts cold water for some hours, and then moderately heated till the solution becomes quite clear; 65 parts boiling water are now added with stirring. In another vessel, 30 parts starch paste are stirred up with 20 of cold water, so that a thin milky fluid is obtained without lumps.

Into this the boiling glue solution is poured, with constant stirring, and the whole is kept at the boiling temperature. After cooling, 10 drops of carbolic acid are added to the paste. This paste is of extraordinary adhesive power, and may be used for leather, paper, or cardboard with great success. It must be preserved in closed bottles to prevent evaporation of the water, and will, in this way, keep good for years.

(5) Fine wheat starch, 1 oz.; beat into a paste with cold water; best glue, 4 oz. Soak the glue, and when soft, boil it and add the starch paste, stirring well. Boil the whole until it is quite thick, and set aside to cool. It keeps well, and when required for use may be instantly dissolved in a little warm water.

(6) 2 oz. starch, 1 oz. white glue, ½ oz. acetic acid, a few drops of oil of cloves. Dissolve the glue in cold water and then boil. Mix the starch with cold water, and pour into the glue while boiling.

(7) Rice flour makes an excellent paste for fine paper work.

(8) Gum tragacanth and water make an ever-ready paste. A few drops of any kind of acid should be added to the water before putting in the gum, to prevent fermentation. This paste will not give that semi-transparent look to thin paper, that gum arabic sometimes gives, when used for mucilage.

(9) Paste that will not sour.—Dissolve 4 teaspoonfuls of alum in 1 gal. water; when cold, stir in as much flour as will give it the consistency of thick cream, beat smooth, add 1 teaspoonful of pulverized rosin, and 20 drops oil of cloves, pour the whole into 2 qt. boiling water, stirring thoroughly until it is cooked; pour into a glazed earthen vessel, and when cold cover the top with oiled silk, and put it in a cool place; when needed for use, take out a portion and soften with warm water. This will be found very convenient for use at times when very little paste is required at once.

(10) Paste for Paper-hanging.—Take ½ quartern of flour (best biscuit) and put it into a pail, with a small portion of alum, broken up small; mix it up into a stiff batter with warm water; have ready a large saucepan of boiling water, and pour it over the paste, stirring well all the time, or it will be "lumpy." If properly done, it will thicken as the boiling water is poured over it; if it does not thicken, set it over the fire a few minutes, but be sure you stir it, or it will burn. When well thickened, throw a dash of cold water over it, as it prevents it skinning whilst cooling. Use rather thin. You can thin it with cold water.

(11) Trimmers' Paste.—Trimmers' paste requires to be smooth, elastic, as free from moisture as possible, and possessed of great adhesive qualities. If too moist, it will soil the cloth or silk to which it is applied, and if not well cooked it will mould and rot; its adhesive qualities are dependent upon the materials of which it is made, and the manner of mixing and cooking. The materials used are wheat and rye flour. The paste of commerce is made of a very low grade of wheat flour, cooked by steam; it is not a good article for trimmers, as it contains too much surplus moisture. To make wheat paste, select a low grade, but sweet wheat flour, and stir it into cold water until thoroughly dissolved; then place the kettle over a quick fire and stir until it boils; it should be allowed to cook 5 or 6 minutes after it is brought to a boil, and be well stirred while boiling and until it is cool; if made in this way, it will contain no surplus moisture, and will be smooth and free from lumps. For rye paste, select good fine rye flour, place the necessary amount of water in a kettle over a quick fire, and when the water boils pour in the flour slowly, stirring it thoroughly; continue to add flour until the desired thickness is obtained; then allow it to boil about 5 minutes, after which remove it from the fire and continue to stir until boiling ceases, then cover and allow it to stand until it is cold. Rye flour paste made in this way is the smoothest, most adhesive and

elastic paste in use. It is particularly valuable for pasting cloth on wood or leather. The dry paste that gathers on the kettle should not be thrown away; if it is soaked in cold water until it becomes soft, and again heated up to boiling heat, it is stronger and more elastic than when first made. Wheat or rye paste can be preserved from mould, &c., by adding a little carbolic acid or essential oil. The addition of a little dissolved gum arabic adds materially to the adhesive qualities of flour paste. Paste for summer use that will keep a long time is made of rye paste, prepared as above: when cold, pour it on a smooth board and set it in the sun to dry; when dry it can be broken up and saved for use. To prepare it for use, place a small quantity in a kettle and cover it with cold water; allow it to remain until soaked soft, then pour off the surplus water, place the kettle over a quick fire, and stir it until it boils. Another plan is to cook the paste, pour it on a cloth, lay it in a clean, warm place for 10 or 12 hours, roll up the cloth, and lay aside for use. Paste treated in this way will keep sweet for a week or more, even in the hottest weather.

(12) From Vanderdecken's Yarns for Green Hands:—"Next, you will require a good paste that will neither decay nor become mouldy; therefore, mix good clean flour with cold water into a paste well blended together, then add boiling water, stirring well up until it is of a consistency that can be easily and smoothly spread with a brush; add to this a spoonful or two of brown sugar, a little corrosive sublimate, and about half a dozen drops of oil of lavender, and you will have a paste fit to fasten the teeth in a saw." We may add that the paste is none the worse for being a day or two old.

Peasley.—A recipe for this cement was published in a well-known technological journal about the time of the first appearance of the cement. Phin doubts the accuracy of the formula, however, and believes that the Peasley cement was merely a modification of the well-known Armenian cement, which see. The following is the recipe alluded to: Prepare a solution of 200 parts of white glue in water; another of 50 parts isinglass, 3 of gum arabic, and 3 of tragacanth; and finally, another of 1 part shellac in alcohol. Then pour these 3 solutions together, mix them with 24 parts of white lead, and add 12 of the best glycerine, and 200 of alcohol. The mastic thus obtained should be immediately put up in bottles and well corked.

Plasters. — (1) Plaster-of-Paris, baked and ground, acquires great hardness and solidity when left for twenty-four hours, in contact with a solution of alum, and when, after drying in the air, it is submitted to a second baking. (2) Still better results are obtained by employing an aqueous solution containing $\frac{1}{20}$ of borate and $\frac{1}{20}$ of cream of tartar; the plaster, baked and in fragments, is plunged into this solution until it is saturated; then it is calcined, and pulverized. (3) A mixture of silicate of potash, 100 parts; carbonate of potash, 27 parts; and water, 500 parts, may also be used.

Plumbers'.—Black rosin, 1 part; brickdust, 2 parts. The brickdust should be finely powdered, thoroughly dried and added to the rosin when the latter is in a melted state.

Porcelain. —(1) Add plaster-of-Paris to a strong solution of alum till the mixture is of the consistency of cream. It sets readily, and is said to unite glass, metal, porcelain, &c., quite firmly. It is probably suited for cases in which large rather than small surfaces are to be united. (2) Milk is coagulated by means of acetic acid, and the caseine thus formed is well washed in water, and then dissolved in a cold saturated solution of borax; a clear solution is thus obtained which is superior to gum arabic in adhesive power, and is colourless. For porcelain, this liquid is mixed with finely powdered quicklime, and the resulting cement is quickly brushed over the fractured surfaces, which are then bound together; the ware is then dried at a gentle heat. (*Dingler's Polytech. Jl.*)

(3) To resist heat. It is made of Stourbridge clay mixed with a little tow or asbestos to increase its coherence. It should be well beaten before application; the glass or china should be first rubbed over with a little of the cement mixed with water, taking care to press the two edges of the glass or china together. This cement will bear a very strong heat. (4) Take isinglass ½ oz., proof spirit sufficient to dissolve it; to every 2 dr. add finely powdered mastic and finely powdered gum ammoniacum—of each 10 gr. Stir till dissolved. In using, heat the edges to be joined, and let the cement get thoroughly dry before using the article. The gums should be added to solution of isinglass when hot. (5) Calcine oyster-shells; pound and sift them through a sieve, and grind them on a flat smooth stone with a muller, till reduced to the finest powder; then take white of egg, and form the whole into a paste. Join the pieces of glass or china and press together 6 or 7 minutes. This cement will stand both heat and water, and will never yield, if properly done. (6) Plaster-of-Paris and gum. For very small articles this cement answers very well, but must not be too thick when well mixed.

Putty.—(1) Good putty, for general purposes, is composed of raw linseed oil and whiting thoroughly incorporated, and can be made equally well by hand or machinery. The whiting should be dry. Linseed oil foots or "bottoms" is only used on the score of economy—that is, to use up a material that would be objectionable in paint. In the shop, putty is made by hand in winter for summer use, on the putty bench. Dry sifted whiting is mixed with as much oil as will enable it to be well beaten with a mallet, and well kneaded into lumps about the size of a 4 lb. loaf, which are then ranged on a shelf, and left for a week, by which time it will be found they have become very soft. More whiting is now worked in, after which pack in casks, pressing it well down. This putty improves by keeping a few months—that is, gets tougher and more homogeneous. (2) A very strong putty is made of boiled oil and whiting for exposed situations, as skylights, but is not adapted for keeping—it gets too hard. (3) Putty for good inside work is improved by adding white lead. (4) Another putty which requires to be made as wanted (as it gets hard almost immediately) is composed of red lead in powder mixed with boiled oil and turpentine varnish, and is used for fronts of houses or any place requiring a hard putty. (5) Some manufacturers prepare an oil for the purpose by melting 20 lb. rosin and mixing it with 90 lb. linseed oil, the rosin being used for economy sake. (6) For some purposes a drying-oil may be used with the whiting: this is made by mixing 1 gal. linseed oil, 12 oz. litharge, 1 oz. sugar of lead, 1 oz. white vitriol, simmer for some time, allow to cool, and when settled draw it off. (7) French putty. Ruban prepares this substance by boiling linseed oil (7 parts) with brown umber (4 parts) for two hours; 5½ parts of chalk and 11 of white lead are then added, and the whole well mixed. This putty is very durable, and adheres well to wood, even though not previously painted.

Sealing-wax.—In general terms, sealing-wax is compounded of resins, tempered and perfumed with proportions of the softer oleo-resins, and variously coloured. It should be glossy, smooth, not brittle, unaffected by the hottest weather, melt without emitting any smoke or nasty smell, have sufficient tenacity not to drop about when melted, and produce a seal of its own lustre and colour. The chief materials used in its composition are shellac and turpentine. The former is sometimes replaced wholly or partially by other resins, such as sandarac, benzoin, mastic, rosin, and pitch; and the latter by balsams of Peru and tolu, and fragrant essential oils. In addition, there are some neutral substances employed to augment the bulk, as gypsum, chalk, magnesium carbonate, zinc white, &c., as well as the colouring matters.

Ingredients.—Only bleached shellac

is admissible for the finest sealing-wax, though pale samples may do for some light-coloured grades; the ordinary unbleached shellac is fit only for black and brown kinds of sealing-wax. (For bleaching methods, see p. 37.) Of the turpentines used, Venetian is the best; but it may often be conveniently replaced by a mixture of rosin and oil of turpentine, which possesses an advantage in the facility with which its fluidity can be increased or diminished. The turpentine will usually need to be filtered, which is best effected by heating it in a water-bath at the boiling temperature, 212° F. (100° C.), and passing it through linen. Other resins, balsams, and essential oils are used only in minor quantities, and should always be selected of good quality.

The colouring matters employed should be good of their kind, though substances of inferior tinctorial power (and therefore cheaper) are of course resorted to for common kinds of wax.

The most general colour is red. For fine grades cinnabar is necessary; but it so increases the weight of the wax that neutral bodies have to be used with it to counteract this tendency. Cheaper reds are minium, colcothar (Indian red), and bole. Madder lake is now replaced by coal-tar reds, of which the most fiery should be chosen.

Yellows embrace lead chromate (chrome yellow), which is generally used with some neutral white body (as chalk); Cassel or mineral yellow, from fused litharge; and ochre, which is too dull and unpleasant-odoured to be available for any but cheap sorts of sealing-wax.

Greens are best obtained by compounding suitable proportions of blues and yellows, as the fine green pigments in the market are too costly for the purpose.

Blues include Berlin for the darker shades, and ultramarine and mountain blue for the lighter.

The best brown is burnt sienna, though crushed sienna and Cassel brown are used.

Blacks are exclusively represented by carbon in a very fine state of division, as lamp-black, ivory black, soot, &c. This last, which is very much cheaper than the others, may be made equally suitable by judicious treatment, which aims at destroying its brownish tint and unpleasant odour. The treatment consists in careful calcination, which may be conducted in a piece of stove-piping, about 18 in. long, and closed at each end by a tight-fitting cap, one being perforated with a hole somewhat less than a pencil, to allow of the escape of vapours. The pipe is filled to within 1½ or 2 in. of the top, when the covers are attached, and all joints and spaces carefully luted with clay, which may also conveniently form a protective coating to the whole pipe. The latter, when charged, is placed in an open furnace, with the perforated end upmost, and heated to redness. When the contents are thoroughly calcined, the pipe is removed, allowed 24 hours to cool, and emptied. The soot will be found to have acquired a velvety black colour, and to have lost all odour. Frankfort or "vine" black is prepared by charring vine shoots in similar apparatus to that for calcining soot, washing the ash several times with water to remove alkaline salts, and once with water containing 25 per cent. of hydrochloric acid, taking care to use plenty of clean water after the acidulated water.

White pigments are used as much for making bulk as for imparting colour. Chalk is prepared by washing and drying the powder. Gypsum is used in the form of finest plaster-of-Paris, and the crystalline variety (selenite), powdered and washed, for translucent waxes. Magnesium carbonate is useful for mixing with heavy pigments, to reduce the weight, rather than as a colouring ingredient. Zinc white needs no preparation. Baryta or permanent white is valuable for enamel-like waxes, and may easily be prepared by dissolving barium chloride in rain water and precipitating with sulphuric acid; the precipitate is washed several times with clean water, and dried. Flake white is readily produced as follows: Fuming nitric acid is poured over some bismuth in a glass vessel till the metal is all dissolved. The solution is poured into another vessel containing about 100 times as much rain water, and stirred up. A white powder (nitrate of bismuth) is at once precipitated; this is collected, washed, and dried, and is employed for the best enamel-like white sealing-wax.

Mica in fine powder is used to give a metallic lustre to cheap kinds of wax; bronze powder of all shades is employed for the same purpose in better grades.

Mixing.—It is essential that all the ingredients be dry, and to ensure this they are kept in paper bags on a shelf running round the walls of the stove-room at about 18 in. below the ceiling. The order of adding the ingredients is as follows: The resins and turpentine are first melted together; then the neutral bodies (chalk, &c.), if any, are stirred in; next the pigments are added; and the volatile balsams and oils are only introduced at the last moment before "forming." When only one pigment is used, it is simply warmed and stirred into the mass. When a shade is to be produced by a mixture of colours, no neutral bodies are added to the resins, but they are mixed with the colours in a china dish, warmed, and then added to the melted mass. Any required tint is obtained by mixing, and frequent testing.

Melting.—The melting of the mass should be conducted at the lowest possible temperature, sufficing only to keep it in a fluid state. Quantities of 20 lb. to 25 lb. are treated at a time in a vessel large enough to permit quick stirring. Often the furnace used resembles an ordinary cook stove, the fire heating cast-iron plates; but these are objectionable from the inequality of the heating, and the risk of fire. Brannt describes an improved form of melter which serves also for the polishing. It consists of a small furnace about 3 ft. 3 in. high, fed preferably with small coke, having an upper and lower door for regulating the draught, but no grate, the ashes being withdrawn at the lower door. The stove is completely enveloped in a sheet-iron casing at a distance of about 2 in., and at the same height above the floor. The air between the stove and the casing becomes hot, and as it passes away it is replaced by a cold current entering at the 2-in. opening between the casing and the floor. Beside the casing of the stove, and connected with it, stands a table, surrounded by a sheet-iron screen, and bearing a sheet-iron tub filled with sand and provided with iron supports. The tub is covered with a plate of sheet-iron (for catching stray drops of wax), having 4 or 6 holes, which contain the melting pots. The hot air arising from the stove heats the sand tub and its contents, till the sealing-wax in the pots begins to melt. As soon as it melts, the fire is slackened by closing the lower door, as the heat retained by the sand suffices for a long time to keep the mass in a fluid state. Enamelled cast-iron pots are best for melting in, keeping a separate pot for each mixture. Before using a pot for a new colour, it must be allowed to get quite cold, when the adhering wax can be easily cleaned off. The shellac is first put into the pot and melted, while being continually stirred with a flat paddle of hard wood; the turpentine is then intimately incorporated; next follow the neutral bodies and colours in a thin stream, with constant stirring, which is more necessary if the pigments are heavy When the mass seems uniform, drops of it are examined by letting them fall on a cold, smooth, metallic plate, when the colour, hardness, and fracture can be tested. When satisfactory, the heat is adjusted to maintain a fluid condition, aromatic substances are quickly stirred in, and "forming" is commenced.

Forming.—Sealing-wax is moulded into sticks in special "forms," consisting of one piece for rectangular or triangular sticks, but must be of two for oval or round. Forms in one piece are made of rectangular brass plate, carrying grooves $\frac{1}{16}$ in. wider at top than at bottom, for facilitating removal of the sticks. It is a common practice to put forms on a stove, or cool them off while moulding by placing them on metallic trays with cold water beneath, to cool the sticks rapidly; this releases the forms more quickly, but makes the sticks brittle, and it is better to let them cool gradually on a wooden table, while if the form becomes so warm as to much protract the setting of the wax, it may be dipped in cold water and carefully dried before using again. Engraved forms are difficult to turn out, but this may be partly remedied by slightly rubbing the engraved parts with oil of turpentine. Surface ornamentation, as gilding or silvering, is effected by placing the substance in the form. As brass forms are expensive, they are sometimes replaced by home-made ones of type-metal. To produce them, a stick of fine wax is coated with a thin film of olive oil, and a cast of it is taken in plaster-of-Paris; when this is thoroughly dry, it is put into a small wooden box, and melted type-metal is poured round to make a form. The forming of the wax is conducted as follows. The molten wax is ladled from the pot into a casting spoon, previously heated. By this it is poured in a uniform stream into the forms. These should be slightly warmed before the first moulding takes place.

Polishing.—Polishing, dressing, or enamelling is usually applied to all grades, though the finer qualities have a lustrous surface on coming out of the form. When the improved furnace before mentioned is not in use, a special polishing stove is necessary. This consists of an iron slab covering a vault, heated by a fire beneath. The sticks are taken in the hand and held in the heat of the polishing stove till the surfaces begin to melt and the sticks bend. When thus softened, they receive an imprint of the maker's name or some other device, composed of letters held in a little brass hand frame. The sticks are patted between small wooden boards at the same time, to retain their shape. For gilding, silvering, or bronzing, the part to be ornamented is touched with a brush dipped in strong spirits of wine, and the gold or silver leaf, or bronze powder is applied, and adheres tenaciously.

Composition.—The following recipes for the compounding of sealing-waxes will be found to embrace all that are of general utility.

Black.—(1) 5 parts shellac, 9 turpentine, 6½ pine resin, 4 chalk, 1¼ soot.

(2) 8 parts shellac, 6 turpentine, 6 resin, 1½ chalk, 1 gypsum, 3½ vine-black.

(3) 48 parts shellac, 52 turpentine, 46 pine resin, 28 chalk, 8 soot, 8 bone-black, 8 asphaltum.

Blue.—(1) 7 parts shellac, 6 turpentine, 3½ pine resin, 1 magnesia, 2 chalk, 2 to 2½ blue colouring matter. (2) Light-blue sealing-wax is produced by mixing Berlin blue with oxide of zinc or nitrate of bismuth, and has a beautiful enamel-like appearance. As blue colours are very sensitive, bleached shellac should always be used, and care must be exercised in the choice of the rosin, that which is opaque and brown-coloured being rejected.

Bottle.—The most ordinary sorts of sealing-wax are used for bottles, and of course can only be coloured with the cheapest kinds of tinctorial matter. Many makers prepare bottle-wax of a mixture of common pine resin, turpentine, chalk, and the respective colouring matter only. Such are very cheap, but they do not answer the purpose so well as they should. The corks are covered with a layer of sealing-wax by dipping the necks of the bottles into the melted mass. This congeals very quickly on the cold glass, and consequently at once becomes brittle, and frequently breaks when gently touched. On trying to make the wax less brittle by increasing the turpentine, it often happens that it remains sticky even in cold weather. To avoid these evils, add a certain quantity of shellac, 10 to 15 per cent., to the composition. This will increase the cost of the article somewhat, but its quality will be so much improved, that it will not become sticky even in a hot climate.

(1) Resin, 6 oz.; shellac, 2 oz.; Venice turpentine, 2 oz.; melt and add lamp-black, 9 oz. Pour into moulds. (2) Common resin, pitch, and ivory black, equal parts. (3) Another: common resin, 20 lb.; tallow, 5 lb.; lamp-black, 4 lb.; mix with heat. (4) Red: common resin, 20 lb.; tallow, 5 lb.; red lead, 6 lb.; mixed with heat. (5) 4 oz. shellac, 1 oz. Venetian turpentine, and 3 oz. vermilion. Melt the lac in a copper pan, suspended over a clear charcoal fire, then pour the turpentine slowly into it, and soon afterwards add the vermilion, stirring briskly all the time of the mixture with a rod in either hand.

Brown.—7 parts shellac, 6 turpentine, 4 pine resin, 2 gypsum, 2 chalk, 2 umber. The shellac for preparing chocolate-brown sealing-wax must not be too dark. The product of the above recipe is dark-brown, and unbleached shellac and dark resin may be used for preparing it.

Deed.—Large seals for deeds and public documents are not imprinted in ordinary sealing-wax, but a mass which is half soft, even at normal temperatures, is used for the purpose, and to protect the seal from injury, it is enclosed in a special case fastened to the document by cords or ribbons.

(1) 6 parts light-coloured rosin, 3½ turpentine, 3 clarified tallow, 4 whiting, 3 to 4 minium. (2) 5 parts white wax, 1½ turpentine, 1 cinnabar, ½ glycerine. The ingredients are melted together and stirred while cooling off until they congeal.

(3) 3 parts colophony, 1⅓ tallow, 3 turpentine, 4 chalk, 4 minium. This mixture is of firm consistency at ordinary temperatures, but if a piece of it is held in the hand for some time, it becomes so soft that impressions can be taken with it, and it adheres also with some tenacity to paper, wood, and glass.

Green.—(1) 7 parts shellac, 8 turpentine, 4 pine resin, 1½ magnesia, 2½ Berlin blue, 2½ chromo yellow. (2) 5 parts shellac, 4 turpentine, 8 pine resin, 1½ gypsum, 2 chalk, 3 mountain blue, and 3 ochre. Green ultramarine may be used to advantage for the finer qualities, instead of a mixture of colours.

Letter, without a light.—3 parts colophony, 3 resin, 3 suet, 4 Venice turpentine, 4 pulverized carbonate of lime, 4 pulverized minium. Melt the 3 first ingredients together, then add the others in succession, stirring constantly till cold.—(*Moniteur Quesneville.*)

Parcel.—(1) 3½ parts shellac, 6½ rosin, 5 turpentine, ½ oil of turpentine, 2¼ chalk, 1 gypsum, 2⅓ cinnabar.

(2) 2 parts shellac, 8 rosin, 5 turpentine, ½ oil of turpentine, 3 chalk, 5½ gypsum, 6 minium.

(3) 1½ parts shellac, 8½ resin, 6 turpentine, ½ oil of turpentine, 2 chalk, 1 brickdust, 5 colcothar.

(4) 20 parts colophony, 10 pine resin, 5 turpentine, 7½ chalk, ⅓ oil of turpentine.

(5) For brown, 10 parts umber or bole are added to (4).

Red.—The beauty and price of red sealing-wax are determined by the quantities of shellac and cinnabar contained in it; only the finest qualities have cinnabar exclusively as a colouring principle. The inferior kinds contain very little shellac, but much common rosin, and no cinnabar at all, minium, colcothar, bole, or other cheap pigments being substituted. But too much resin must not be added, or the wax will become too thin, drop too easily, and smoke very much when lighted. It is asserted that chalk should not be used, because the acids of the shellac expel carbonic acid from it, and form a combination with the lime; but this happens only when the shellac is heated more than necessary, as no carbonic acid is set free if the shellac is only heated to the melting-point.

Very fine reds are—(1) 12 parts shellac, 8 turpentine, 9 cinnabar, 2 oil of turpentine, 3 magnesia.

(2) 11 parts shellac, 6 turpentine, 1 oil of turpentine, 1 chalk, 2 magnesia, 8 cinnabar.

(3) 10 parts shellac, 1 turpentine, ½ oil of turpentine, 1½ chalk, 1½ gypsum, ⅕ magnesia, 6½ cinnabar.

(4) 50 parts shellac, 12½ Venice turpentine, 37½ Chinese vermilion.

Medium fine reds.—(1) 1 part shellac, 8 turpentine, ½ oil of turpentine, 3 chalk, 1 magnesia, 6 cinnabar.

(2) 6 parts shellac, 4 resin, ½ oil of turpentine, 7 turpentine, 1½ chalk, 1½ gypsum, 4½ cinnabar.

(3) 4 parts shellac, 6 resin, 6 turpentine, ½ oil of turpentine, 2 chalk, 1 gypsum, 4 cinnabar.

Fine red.—55 parts shellac, 74 turpentine, 30 chalk or magnesia, 20 gypsum or zinc white, 13 cinnabar.

Ordinary red.—(1) 52 shellac, 60 turpentine, 44 pine resin, 18 chalk, 18 cinnabar. (2) 50 resin, 37½ red lead, 12½ turpentine.

Translucent. — Translucent sealing-wax belongs to the very best qualities, as only highly refined materials can be used for it. Bleached shellac alone is not sufficient; sealing-wax only becomes translucent by adding a corresponding quantity of mastic, and by using very fine, light-coloured, and very viscid turpentine. Following are 3 recipes for preparing translucent sealing-wax, which may be coloured by mixing suitable pigments with it. A beautiful variety ("aventurin"), which can be prepared at comparatively low cost, is obtained by stirring finely powdered mica into the melted ground mass. Gold and silver waxes are obtained by mixing finely powdered leaf-metal with the melted ground mass. Ground masses for translucent wax are:—(1) 1½ parts bleached shellac, 1½ viscid turpentine, 3 mastic, 1 chalk.

(2) 3 parts bleached shellac, 4 viscid turpentine, 5 mastic, 3 sulphate of baryta (or 3 nitrate of bismuth).

(3) 3 parts bleached shellac, 4 viscid turpentine, 5 mastic, 3 sulphate of baryta (or 3 nitrate of bismuth). No. (3) is especially adapted for preparing "enamelled" sealing-wax, which actually possesses the half transparent appearance of enamel, and is particularly beautiful when a tender rose-colour is given to it by using fiery madder-lake.

Yellow.—Only lead colours can be used for yellow sealing-wax, and of these chrome yellow produces the most beautiful colour. But if sealing-wax compounded with chrome yellow is very strongly heated in lighting it, the mass becomes discoloured, in consequence of a decomposition of the lead colours. Therefore yellow sealing-wax must be very fusible to avoid this evil. Every kind of sealing-wax becomes more fusible by adding a larger quantity of turpentine, but it also becomes softer. Fine yellow: 76 parts shellac, 85 turpentine, 45 pine resin, 15 gypsum, 15 chalk, 45 ochre. The shellac used for fine qualities of yellow sealing-wax must be bleached, or it will be impossible to produce a pure tone of colour. All gradations of yellow, from orange to red, can be produced by adding cinnabar or chrome-red to fine qualities, and minium to inferior qualities of sealing-wax.—(*Brannt.*)

Shellac.—(1) Shellac, made up into sticks of the size of a lead pencil, is frequently sold as a cement which will resist water, acids, oils, &c., and it answers very well. Sometimes it is mixed with very fine powders, either to give it body, or to colour it. Zinc white or plaster-of-Paris may be used to make it white; ivory black, for black; brick-dust, red ochre, and vermilion for different shades of red. The objects to be cemented together are first warmed till they melt the shellac brought into contact with them. This is very good to cement broken glass, porcelain, &c., especially as the objects are again ready for use immediately when cold; but it is not adapted for flexible objects, as it cracks. It will not withstand heat or alcohol, which softens the shellac. Shellac is soluble in alcohol, when it forms what is known as Chinese glue. It is also soluble in wood naphtha. Contrary to published statements to that effect, shellac does not form as strong a cement when in the state of solution as when melted by heat. Instead of using alcohol or benzine, a watery solution of borax may be used for dissolving shellac. Take of borax, 100 parts; rain (or distilled) water, 2250 parts; heat to boiling, and while stirring, gradually add powdered shellac, 300 parts. When dissolved, strain through muslin and preserve. This forms a waterproof varnish. Paper soaked with this is waterproof, and resembles parchment. Shellac makes the best black cement for articles of jet. It is made black by smoking it in the flame of a lamp or candle.

(2) *Houde's.*—Shellac, 2 parts; Venice turpentine, 1; fuse together and form into sticks. (3) It is sometimes necessary to pulverize shellac. A correspondent of the *Druggists' Circular* has devised the following method: "Enclose the shellac in a strong, closely-woven piece of cloth, at first compressing the folds rather tightly, but gradually relaxing them. Then, after placing the bunch, which must be held in position with the hand, upon a solid block or smooth counter, the strokes of a heavy iron pestle are applied, gently at first, while the bunch is kept moving from side to side, so as to expose every part to the strokes of the pestle. After the large, sharp pieces are broken, the strokes are increased in velocity and power, with wonderful effect upon the resin, and but little injury to the cloth. In this way shellac may be reduced to granular form sufficiently fine for pyrotechnic purposes at very short notice, and to an almost impalpable powder in a comparatively short space of time. To produce this result, however, it is necessary to wield the pestle forcibly, and then from time to time separate the finer particles from the coarser by sifting."

Soluble Glass.—When finely pulverized chalk is stirred into a solution of soluble glass of 30° B. until the mixture is fine and plastic, a cement is obtained which will harden in 6 or 8 hours, possessing an extraordinary durability, and alike applicable for domestic and industrial purposes. It may be used for uniting stone, brick, &c., and for filling up cracks. In short, it seems to be applicable to about the same purposes for which plaster-of-Paris is used, but it is much harder and stronger. If for part of the chalk some colouring matter be substituted, differently coloured cements of the same general character are obtained. The following materials give good results:—(1) Finely pulverized or levigated stibnite (grey antimony, or black sulphide of antimony) will produce a dark cement, which, after burnishing with an agate, will present a metallic appearance. (2) Pulverized cast iron, a grey cement. (3) Zinc dust (so-called zinc grey), an exceedingly hard grey cement, which, after burnishing, will exhibit the white and brilliant appearance of metallic zinc. This cement may be employed with advantage in mending ornaments and vessels of zinc, sticking well to metals, stone, and wood. (4) Carbonate of copper, a bright green cement. (5) Sesquioxide of chromium, a dark green cement. (6) Thénard's blue (cobalt blue), a blue cement. (7) Minium, an orange-coloured cement. (8) Vermilion, a splendid red cement. (9) Carmine red, a violet cement.

Sorel's.—There are two different cements which go by the name of Sorel's: namely, the "oxychloride of zinc" and the "magnesia" cement.

(1) *Oxychloride of Zinc.*—A solution of chloride of zinc is prepared by dissolving zinc in hydrochloric acid, so that some metallic zinc always remains undissolved. The solution is filtered and concentrated until it has the sp. gr. 1·800. Commercial oxide of zinc is mixed with water containing 2 per cent. of nitric acid to a stiff paste, which, after being dried, is heated in crucibles to a white heat, after which it is reduced to an impalpable powder. The object of this baking is to reduce the oxide to as small a bulk as possible, in which condition it has more binding power. The powder must be kept from contact with the air, to prevent access of moisture and carbonic acid gas. On bringing together the oxide and solution of chloride of zinc, the whole solidifies in a few minutes to a very hard mass. If it is desired to retard the hardening, the zinc solution may be diluted to about 1·500–1·600 sp. gr., and the oxide of zinc may be mixed with 2 to 3 per cent. of borax or chloride of ammonium.

(2) *Magnesia.*—This was originally prepared by Sorel, of Paris, from mag-

nesite (chiefly native carbonate of magnesium), by making a paste with powdered magnesite, 10 to 20 per cent. of hydrochloric acid, and a sufficient quantity of water, forming the mass into bricks, then burning them at a strong heat, and finally grinding them. This yields a very hard, bright-coloured cement, which bears large dilution with sand, but is not entirely waterproof. Since the immense saline deposits at Stassfurt have been worked, this cement is prepared from kieserite (a native hydrated sulphate of magnesium), many thousand tons of which are annually obtained. Kieserite is mixed with calcium hydrate, in the proportion of two molecules of the former to one of the latter, with addition of water; the mass is formed into bricks or cakes, dried, and "burnt," and powdered. The powdered mass when moistened solidifies to a marble-like mass, which does not, however, permanently resist moisture, and is best used only in the interior of buildings.

(3) The following composition forms an excellent material for moulding or for uniting stone, &c. Mix commercial zinc white with ½ its bulk of fine sand, adding a solution of chloride of zinc of 1·26 sp. gr., and rub the whole thoroughly together in a mortar. The mixture must be applied at once, as it hardens very quickly.

Steam.—The lutes usually employed for making steam-tight joints are composed of white lead and litharge in various proportions. See *Lead.* (1) A steam-tight cement which is said to be superior to the ordinary white-and-red lead cement, is obtained by mixing 6 parts of finely pulverized graphite, 3 of slaked lime, 8 of sulphate of barytes, and 7 of boiled linseed oil. These ingredients must be intimately mixed. (2) Dried and powdered clay, 6 lb.; iron filings, 1 lb.; made into a paste with boiled linseed oil; used for stopping cracks and leaks in boilers, stoves, &c. (3) Litharge in fine powder, 2 parts; very fine sand, 1; lime that has been allowed to slake spontaneously in a damp place, 1; mixed, and kept from the air; made into a paste with boiled oil, and used to mend cracks, and secure steam joints. (4) Good linseed-oil varnish ground with equal weights of white lead, oxide of manganese, and pipeclay. (5) Dry, powdered clay, 1 part; clean, sifted iron filings, 2; acetic acid, sufficient to make a paste. (6) Dry, powdered clay, 8 to 10; iron filings, free from rust, 4; peroxide of manganese, 2; sea-salt, 1; borax, 1; water, sufficient to make a paste. (7) Sulphate of baryta, 1 part; clay, 2; made up with solutions of silicate of potash, and borax; it resists a very high temperature. (8) Iron filings, free from rust, 50 parts; flowers of sulphur, 2; pulverized hydrochlorate of ammonia, 1; these substances are mixed with water or urine, so as to make a solid and homogeneous paste, which is used in the joints of steam boilers. The lute swells, becomes very solid, and perfectly closes the joints. (9) Iron filings, 4 parts; loam, 2; powdered sandstone, 1; made into a paste with salt water; becomes very hard on setting. (10) A thick paste, composed of silicate of soda and iron filings; the latter substance may be replaced by a mixture, in equal parts, of powdered oxide of zinc and peroxide of manganese. (11) Sand, 84 parts; Portland stone, 166; litharge, 18; pulverized glass, 0·90; red lead, 0·45; sub-oxide of lead, 0·90; the whole rubbed up with oil.

Stone.—(1) Sulphur, 1 part; yellow wax, 1 part; rosin, 1 part; the sulphur and rosin are melted, and the wax is then added. It is necessary to heat the surfaces to be united; the cement is applied while still hot, and pressure is exerted till it is cold. (2) Powdered gum arabic, 2 parts; finely ground white lead, 2 parts; pulverized sugar-candy, 1 part; the three substances are placed in a small bottle with a wide mouth, a little hot water is poured on them, and the whole is stirred by a stick into a homogeneous paste. The cement must be kept in a closed vessel, and a little water may be added if it becomes dry. Before use, it must be well stirred, to prevent the white lead collecting at the bottom. It is employed for joining fragments of minerals, fossils, &c.

Turners'.—(1) Melt 1 lb. resin in a pan over the fire, and when melted, add a ¼ lb. of pitch. While these are boiling add brickdust until, by dropping a little on a cold stone, you think it hard enough. In winter it may be necessary to add a little tallow. By means of this cement, a piece of wood may be fastened to the chuck, which will hold when cool; and when the work is finished, it may be removed by a smart stroke with the tool. Any traces of the cement may be removed from the work by means of benzine. (2) The heat necessary to melt the ordinary turners' cement is liable to warp thin plates of brass, and in some cases, as for example circles of mathematical instruments that require to be graduated, this is very objectionable. In such cases plaster-of-Paris is the best cement to use. (3) ½ oz. rosin, ½ oz. pitch, 1 oz. beeswax; melted together, sufficient fine brickdust added to produce desired consistence. (4) 2 lb. rosin, 2 lb. Burgundy pitch, 2 lb. dried whiting, 2 oz. yellow wax; melted and mixed together. (5) ½ lb. black rosin, 1 oz. yellow wax; melted together, and poured into a tin canister.

Waterproof.—(1) Glue to which bichromate of potash has been added, and which has afterwards been exposed to strong sunlight, becomes insoluble. The proportions are not very well ascertained, but about 1 part of the bichromate, dissolved in water, and added to a solution of 6 parts of solid glue, answers very well. (2) The following is a valuable cement which, if properly applied, will be insoluble even in boiling water: Gelatine, 5 parts; soluble acid chromate of lime, 1. Cover the broken edges with this, press lightly together, and expose to the sunlight; the effect of the latter being to render the compound insoluble. (3) It is said by the *British Journal of Photography*, that the following recipe gives excellent results: Take alcohol, 1 pint; sandarac, 1 oz.; mastic, 1 oz.; common white turpentine, 1 oz.; glue and isinglass, sufficient; water, sufficient. Dissolve the two resins—sandarac and mastic—in the spirit, and then add the turpentine to the solution. Make some very strong glue, and add to it a good pinch of isinglass. Now heat the alcoholic varnish until the liquid begins to boil, then very slowly stir in the warm glue. The amount of the liquid glue to be added is determined by noting the point at which, after thorough mixture, a magma or thin paste is formed, capable of being easily strained through cloth. When required for use, the strained mixture is to be warmed, and applied like ordinary glue to the articles to be united. A strong junction is effected, which is not destroyed by cold water, and only after a comparatively considerable time by hot water or ordinary saline solutions. (4) Glue, 1 part; skimmed milk, 8. Melt and evaporate in a water-bath to the consistence of strong glue. This cement cannot be called waterproof, but it resists the action of water better than common glue. (5) Melt common glue with as little water as possible, add ⅛ of boiled linseed oil, dropping it gently into the glue, which is to be stirred all the time. (6) From the account published by C. Puscher, in *Kunst und Gewerbe*, of the many experiments which he has made to render cement and lime plaster proof against the effects of the weather, it appears that a cold solution of 1 part green copperas in 3 of water is extremely effective. Cement manufactures are put into the solution for 24 hours, and then, coloured greenish black by the oxidulated iron hydrate which has been formed, dried in the air. The absorbed solution of copperas has been decomposed in the cement, and the combination of hydrated peroxide of iron formed is stated not only to render the cement denser and harder, but also, as it is not affected by the weather, to impart to it greater resistance. The weight of the cement is increased by 10 per cent., without any change in form. Cement plaster is protected against the effects of the weather by repeated applications of the copperas solution. If, after the 4th application, the cement does not turn a dark greenish-black, it is a sign that the surface has become saturated with the iron combination. After drying, a coating is formed on the cement of an ochre-like colour, which cannot be washed off with water, and which will take water-colours. If cement plaster thus prepared is to be permanently painted with oil colours—which, as is well known, peel off ordinary cement—two applications of 5 per cent. soap water are sufficient to render it waterproof, and, after drying and rubbing with a cloth, as shiny as oil colour, so that one coating of the latter may be saved. In order to protect cement manufactures prepared with copperas against acids, alkalies, and the influence of the weather, a layer of a heated mixture of equal parts of ordinary paraffin and paraffin oil, or petroleum, is sufficient, which is obtained by immersing the heated cement articles in it for a few minutes. This cheap copperas solution may also be used for old or new lime plaster; old lime plaster must, however, first be freed from loose particles of colour by washing off. It is not advisable to mix the cement and sand at once with the copperas solution, as cement thus prepared cracks after drying. (*Builder.*) (7) Tar, 1 part; tallow, 1; fine brickdust, 1; the latter is warmed over a very gentle fire; the tallow is added, then the brickdust, and the whole is thoroughly mixed. It must be applied while hot. (8) Good grey clay, 4 parts; black oxide of manganese, 6; limestone, reduced to powder by sprinkling it with water, 90; mixed, calcined, and powdered. (9) Manganese iron ore, 15 parts; lime, 85; calcined and powdered. Both (8) and (9) require to be mixed with a little sand for use; thrown into water, they harden rapidly. (10) Fine, clean sand, 1 cwt.; powdered quicklime, 28 lb., bone ash, 14 lb. Beaten up with water for use. (11) Quicklime, 5 parts; fresh cheese, 6; water, 1. The lime is slaked by sprinkling with the water; thereupon it is passed through a sieve, and the fresh cheese is added. The latter is prepared by curdling milk with a little vinegar, and removing the whey. The cement thus formed is very strong; but it requires to be applied immediately, as it sets very quickly. (12) Fresh curd, as before, 1 part; quicklime, 1; Roman cement, 3. Used for joining stone, metals, wood, &c. (13) A paste composed of hydraulic lime and soluble glass. (14) 1 glue, 1 black rosin, ¼ red ochre, mixed with least possible quantity of water. (15) 4 glue, 1 boiled oil by weight, 1 oxide of iron. (16) Mix a handful of quicklime with 4 oz. linseed oil, thoroughly lixiviate the mixture, boil it to a good thickness, and spread it on tin plates in the shade. It will become very hard, but it can be dissolved over a fire, like common glue, and is then fit for use.

Wollaston's.—This is a very valuable cement for large objects, such as shells, fossils, &c.: Beeswax, 1 oz.; resin, 4 oz.; powdered plaster-of-Paris, 5 oz. Melt together. To use, warm the edges of the specimen, and use the cement warm.

Wood.—(1) For wooden vessels. A mixture of lime, clay, and iron oxide, separately calcined, and reduced to fine powder, then intimately mixed, kept in a close vessel, and made up with the requisite quantity of water when wanted. (2) For wood. The following cement will be as hard as stone when dry, and will adhere firmly to wood. Melt 1 oz. resin and 1 oz. of pure yellow wax in an iron pan, and thoroughly stir in 1 oz. of Venetian red, until a perfect mixture is formed. Use while hot. (3) For cracks in wood. (*a*) Slaked lime, 1 part; rye meal, 2 parts; made into a paste with a sufficient quantity of linseed oil; (*b*) Glue, 1 part, dissolved in water, 16 parts; when almost cold, sawdust and prepared chalk are stirred in to the required consistence; (*c*) Oil varnish, thickened with a mixture of equal parts white lead, red lead, litharge, and chalk.

Zeiodelite.—This cement consists of 19 parts of sulphur, and 42 of powdered glass or earthenware, mixed thoroughly together by heating the sulphur. It may be used instead of hydraulic cement for uniting stones or bricks, and for cementing iron rods into holes cut in stone.

CLEANSING.—This article embraces the cleaning and scouring processes employed by dyers, recipes for washing and cleansing various things not coming within the dyer's art, and prescriptions for the removal of stains. The whole subject is arranged under alphabetical sub-headings.

Brass.—(1) Wash with rock alum, boiled in a strong lye in the proportion of 1 oz. to a pint; polish with dry tripoli. (2) The government method prescribed for cleaning brass, and in use at all the United States arsenals, is claimed to be the best in the world. The plan is to make a mixture of 1 part common nitric acid and ½ part sulphuric acid, in a stone jar, having also ready a pail of fresh water and a box of sawdust. The articles to be treated are dipped into the acid, then removed into the water, and finally rubbed with sawdust. This immediately changes them to a brilliant colour. If the brass has become greasy, it is first dipped in a strong solution of potash and soda in warm water; this cuts the grease, so that the acid has free power to act. (3) Rub the surface of the metal with rottenstone and sweet oil, then rub off with a piece of cotton flannel, and polish with soft leather. A solution of oxalic acid rubbed over tarnished brass soon removes the tarnish, rendering the metal bright. The acid must be washed off with water, and the brass rubbed with whiting and soft leather. A mixture of muriatic acid and alum dissolved in water imparts a golden colour to brass articles that are steeped in it for a few seconds. (4) First boil your articles in a pan with ordinary washing soda, to remove the old lacquer; then let them stand for a short time in dead aquafortis; then run them through bright dipping ditto. Swill all acid off in clean water, and brighten the relieved parts with a steel burnisher, replace in clean water, and dry out in beech sawdust. Next place your work on stove till heated, so that you can with difficulty bear your hand on articles, and apply pale lacquer with brush: the work will burn if heated too much or too rapidly. (5) Put a coat of nitric acid over the part you want cleaned, with a piece of rag; as soon as it turns a light yellow, rub it dry and the brass will present a very clean appearance; if not, repeat. (6) Oxalic acid and whit[illegible] mixed and applied wet, with brush, [illegible]

(7) Brass instruments. [illegible] ments are very much oxidized or covered with green rust, first wash them with strong soda and water. If not so very bad, this first process may be dispensed with. Then apply a mixture of 1 part common sulphuric acid and 12 of water, mixed in an earthen vessel, and afterwards polish with oil and rottenstone, well scouring with oil and rottenstone, and using a piece of soft leather and a little dry rottenstone to give a brilliant polish. In future cleaning, oil and rottenstone will be found sufficient. (8) Take a strip of coarse linen, saturate with oil and powdered rottenstone, put round the tubing of instrument, and work backwards and forwards; polish with dry rottenstone. Do not use acid of any kind, as it is injurious to the joints. To hold the instrument, get a piece of wood turned to insert in the bells; fix in a bench vice. The piece of wood will also serve for taking out any dents you may get in the bells. (9) Oil and rottenstone for this purpose, are, though very efficacious, objectionable on account of dirt, on account of the oil finding its way to the pistons, and because the instrument cleaned in this manner so soon tarnishes. Dissolve some common soda in warm water, shred into it some scraps of yellow soap, and boil it till the soap is all melted. Then take it from the fire, and when it is cool add a little turpentine, and sufficient rottenstone to make a stiff paste. Keep it in a tin box covered from the air, and if it get hard, moisten a small quantity with water for use. (10) Brass or Copper.—Mix together 1 oz. oxalic acid, 6 oz. rottenstone, and

½ oz. gum arabic; all these are to be finely powdered. Then add 1 oz. sweet oil and sufficient water to form the mixture into a paste. Apply a small portion to the article to be cleaned, and rub dry with a flannel or washleather.

Bronze.—(1) There has been found no other way of cleaning bronze statues, when blackened by smoke and soot, than that of washing with plenty of clean water, accompanied with mechanical friction; and it has been generally allowed, in the numerous discussions which have occurred on the subject, that even this simple treatment was very undesirable; because the friction, however slight, accompanying the washing, destroys, or tends to destroy, the sharpness of the outlines; and the sulphurous and sulphuric acids of the prevailing smoke would be certain to rapidly corrode the surface of any bronze statue which is constantly being washed. For these reasons, the Nelson monument at Liverpool, was left untouched when it was re-erected, after the building of the new Exchange surrounding it. It has been a matter of much debate whether the soot-blackened surface of a bronze statue is not more pleasing to the eye, than the metallic lustre of a new, or newly-cleaned statue. (2) Weber finds that a dilute solution of caustic alkalies removes overlying dirt, and allows the green patina to become visible. Where the metal was not originally oxidized, the alkali simply cleanses it, and does not promote any formation of green rust. (3) By dipping fustian in soluble glass, and washing it with soap directly afterwards, we get a fabric largely impregnated with silica, which will be found very well adapted for cleaning bronzes, &c. Samples of the material were in the Vienna Exhibition, and attracted some notice. (4) The method of restoring a bronze tea-urn turned black in parts will depend, to a great extent, on the metal and the colour. Clean the surface, first of all, with whiting and water, or crocus powder, until it is polished; then cover with a paste of graphite and crocus, mixed in the proportions that will produce the desired colour. Heat the paste over a small charcoal fire. If the bronzing has been produced by a corrosive process, try painting a solution of sulphuret of potassium over the cleaned metal. There are many recipes for bronzing, and it is impossible to say which is suitable. The bronzed surface may be polished; but it cannot be bright unless the surface of the metal itself is polished, and then covered with transparent lacquer to preserve the brightness.

Casks.—The acid smell very often found in casks may be attributed to absorption in the pores of the wood of acetic and lactic acids—a very small quantity of either of them having power to communicate their principle to any fermenting liquid with which they may be brought in contact, and increasing very fast at the expense of the alcohol in the liquid, while at the same time causing unsoundness to a greater or less extent, according as the temperature of the atmosphere may be high or low. Bearing this in mind, it is of the utmost importance that all free acid which the cask may contain should be carefully neutralized before filling with a liquid so liable to change as fermenting wort. Casks before filling, after being well washed with boiling water, should be allowed to cool, and then examined by some responsible person as to their cleanliness, acidity, and probable mustiness; the cask is well smelt, and usually a light is passed through the tap-hole, so that the examiner may view the interior. Any cask that may smell sour (especially in summer weather, or when required for stock or pale ales) should be rejected, and be well treated with lime. This should be put into the casks *dry*, small lumps of the lime being broken, so that they can be easily inserted in the bung-holes, and when sufficient has been put in (say, about 4 lb. to a barrel), then about 4 gal. of *boiling* water must be added, the casks bunged up, and kept so for a few hours, occasionally rolling about. The lime should then be well washed out, and the casks steamed, and allowed to cool, when they will be in a fit condition for containing the most delicate liquid without any injury. The hard brown substance, which on being scraped with a nail leaves a white mark, so often found in casks, is a deposit that forms from the constituents of the liquid contained in them, and is often carbonate of lime, or yeast dried, or both. When this is formed, the only effectual method of cleansing is to take out the head, and put it into the cooper's hands to be well scraped, until every particle of the fur is removed. Cask-washing machines never remove fur or thick dry deposit properly; they are very convenient in a general way for the usual run of casks, but any exceptionally bad must be unheaded, and cleaned by hand. For stock ales it is a good plan to rinse with solution of bisulphite of lime just before filling trade casks. (2) With regard to the coating spoken of in (1), it not only preserves the wood but keeps it clean and sweet, and does no harm at all to the beer. It takes some considerable time before the wood is coated with such a protecting enamel. It occurs alike in rounds, puncheons, and stone squares. Formerly it was customary to have all vessels that were furred over thoroughly dressed by the cooper, but now intelligent coopers advise brewers to keep it on. (3) Blow sulphur fumes into foul casks by fumigating bellows, such as gardeners use when fumigating conservatories. The sulphurous acid formed by burning brimstone is a powerful purifier, and will not leave an unpleasant taste, being easily washed away. (4) Cider casks.—Half fill each cask with boiling water, and add ¼ lb. of pearlash, then bung it up, and turn over occasionally for 2 days, then empty, and wash with boiling water. (5) Scald out with boiling water; if the heads are out, put them over a straw fire for a few minutes, so as to slightly char the inside. If you have a steam boiler, partially fill with water, and admit steam through the bung-hole by a pipe down into the water, and so boil. (6) Vinegar casks.—Old vinegar barrels become impregnated to such an extent with acetous substances that it is next to impossible to render them fit for the storage of any other liquid. Fill the barrels with milk of lime, and let this remain in them for several months, then rinse out well with plenty of warm water, and steam them inside for ½ hour.

Celluloid covered Mountings.—Rub the covered parts with a woollen cloth and a little tripoli, and polish with a clean woollen rag.

Chip or Straw Bonnets.—*To Clean.*—Wash in warm soap liquor, well brushing them both inside and out; then rinse in cold water, and they are ready for bleaching.

To Bleach.—(1) Put a small quantity of salts of sorrel or oxalic acid into a clean pan, and pour on it sufficient scalding water to cover the bonnet or hat. Put the bonnet or hat into this liquor, and let it remain in it for about 5 minutes; to keep it covered, hold it down with a clean stick. Dry in the sun or before a clear fire. (2) Having first dried the bonnet or hat, put it, together with a saucer of burning sulphur, into a box with a tight closing lid. Cover it over to keep it in the fumes, and let it remain for a few hours. The disadvantage of bleaching with sulphur is that the articles so bleached soon become yellow, which does not happen to them when they are bleached by oxalic acid.

To Finish or Stiffen.—After cleaning and bleaching, white bonnets should be stiffened with parchment size. Black or coloured bonnets are finished with a size made from the best glue.

Straw or chip plaits, or leghorn hats and bonnets, may also be cleaned, bleached, and finished as above.

Coins. — Coins can be quickly cleansed by immersion in strong nitric acid, and immediate washing in water. If very dirty, or corroded with verdigris, it is better to give them a rubbing with the following:—

½ oz. pure bichromate of potash.
1 oz. sulphuric acid.
1 oz. nitric acid.

Rub over, wash with water, wipe dry,

and polish with rottenstone or chalk. (Lyle.)

Copper Vessels.—(1) Use soft-soap and rottenstone, made into a stiff paste with water, and dissolved by gently simmering in a water-bath. Rub on with a woollen rag, and polish with dry whiting and rottenstone. Finish with a leather and dry whiting. See also *Brass.*

Druggists' Utensils. — Before cleaning an implement, the first thing to consider is whether the article you are about to wash is worth the chemical you will have to waste upon it. If not, then throw it away; if otherwise, the chemicals are not wasted. Do not count the labour, as it would be the same even if merely washing with water. On any article use water first—pure water, or as pure as it runs from the hydrants, and next to that soap. I place water first, as it ought to be, in an apothecary's shop. Other people place soap first; but soap is incompatible with a great many chemicals employed in a drug store, and in some cases had better be left out altogether. Water will dissolve out most iodides, nitrates, sulphates, chlorides, &c., with which soap is incompatible, even if they are incorporated with fatty substances, as in ointments. We have known clerks to dash soapsuds right into a graduate that has contained tincture of iron, or solutions of lead or lime, and then have a graduate more difficult to wash out than before, while, if they had used water alone, it would have been cleansed.

Cheapness is the thing to be desired in washing paraphernalia. Some druggists use powdered pumice, sawdust, sand brick, shot, wire and paper, solutions of soap in diluted alcohol, and of caustic potash in water, turpentine, ammonia, benzine, alcohol, ether, chloroform, hot water, and hydrochloric, nitric, and sulphuric acids. Some of the above are to be recommended, and others are not; for instance, powdered pumice is an excellent thing for scouring wedgwood mortars and brightening spatulas. It is also useful when introduced into bottles on paper and a bent wire employed for scouring.

Dry sawdust is good for removing grease from mortars and spatulas after ointments have been made, and in soaking up oil and paint from floors when spilled. Sand brick is useful in scouring spatulas. Shot for washing bottles I do not recommend, not so much from fear of lead poisoning, but because there are better methods for the same purpose, and less expensive. Shot that has been thrown into a greasy bottle becomes coated with fat, and is unfit for further use, as it will only dirty the next bottle it is thrown into. The shot itself, when once dirty, is hard to clean, and had better be thrown away. A very handy instrument is the bent wire and paper. With a good steel wire bent into proper shape, and introduced into bottles, we can accomplish wonders. A piece of newspaper, moistened and sprinkled with powdered pumice, will scour out of a bottle all dirt of a resinous character. If the bottle has contained any solutions of iron salts, use hydrochloric acid. A bottle that has contained lime water, or in which lime has deposited, is most readily cleansed by hydrochloric acid. The same is true of oxide of zinc when used in a mortar for making ointments. A mortar, after zinc ointment has been prepared in it, if washed ever so much with soap and water, still causes a little water dropped into it to run into globules, showing the presence of zinc or other substance in the mortar. A few drops of muriatic acid dropped into it will remedy this, forming chloride of zinc, a very soluble salt.

Nitric acid will best cleanse a vessel that has contained lead solutions, as the other acids form insoluble lead compounds. Carbonate of soda put into fish-oil or cod-liver-oil bottles, and allowed to stand a few hours, will cleanse them perfectly. A solution of crude potash is an excellent thing to keep on hand, as it is to be preferred to alcohol, ether, benzine, or chloroform, in cleaning vessels that have contained resins, such as liquid styrax, tolu, benzoin, and all dirt of a resinous character; it is also useful in cleaning vessels which have contained Prussian blue. Alcohol is useful in removing chlorophyll. For ether and chloroform I have no use, as they are too volatile and too expensive.

Hot water for grease is not to be recommended, because it is not handy to get, and it only melts the grease, and causes it to float on its surface, and when the water is poured out of the vessel the fat will still adhere to its sides, and have to be washed off with soap and water. Turpentine is useful in removing tar, wax, or resin. I never have had enough success with ammonia to recommend it. It destroys paint if put on counters or shelving, and makes windows look smeary. The only thing it is good for is to neutralize acids that may have fallen on clothing. Oxalic acid will temporarily remove tannate of iron stains. Use whiting, or better, precipitated chalk on your plated show cases, and rottenstone on brass work. A chamois skin is good to brighten up things with, but a new one scratches, and an old one, if washed, is hard and stiff.

And now we come to the last, but not least important, and that is the hands; all the above solvents and detergents will do for the hands if used in moderation, and then immediately removed with clear water. (A. Wetterström.)

Engravings. — (1) Presuming these to be mounted, proceed in the following manner. Cut a stale loaf in half, with a perfectly clean knife; pare the crust away from the edges. Place the engravings on a flat table, and rubbing the surface with the fresh-cut bread, in circular sweeps, lightly but firmly performed, will remove all superficial markings. Soak the prints for a short time in a dilute solution of hydrochloric acid, say 1 part acid to 100 of water, and then remove them into a vessel containing a sufficient quantity of clear chloride of lime water to cover them. Leave them here until bleached to the desired point. Remove, rinse well by allowing to stand an hour in a pan in which a constant stream of water is allowed to flow, and finally dry off by spreading on clean cloths. Perhaps may require ironing between two sheets of clean paper. (2) Put the engraving on a smooth board, cover it thinly with common salt finely pounded; squeeze lemon-juice upon the salt so as to dissolve a considerable proportion of it; elevate one end of the board, so that it may form an angle of about 45° or 50° with the horizon. Pour on the engraving boiling water from a tea-kettle until the salt and lemon-juice be all washed off; the engraving will then be perfectly clean, and free from stains. It must be dried on the board, or on some smooth surface, gradually. If dried by the fire or the sun it will be tinged with a yellow colour. (3) Hydrochloric acid, oxalic acid, or eau de Javelle may be employed, weakened by water. After the leaves (if it be a book) have by this means been whitened, they must be bathed again in a solution of sulphate of soda, which will remove all the chlorine, and leave the leaves white and clean. They will, however, have lost all firmness of texture, owing to the removal of the size from the paper. It will, therefore, be advisable to give a bath of gelatine and alum made with boiling water, to which may be added a little tobacco, or any other simple substance to restore the tint of the now too white paper. (4) Immerse each mildewed sheet separately in a solution made in the proportions of ½ lb. chloride of lime to a pint of water. Let it stand, with frequent stirring, for 24 hours, and then strain through muslin, and finally add 1 qt. water. Mildew and other stains will be found to disappear very quickly, and the sheets must then be passed separately through clear water, or the chloride of lime, if left in the paper, will cause it to rot. Old prints, engravings, and every description of printed matter may be successfully treated in the same manner. (5) "I have in my time cleaned many hundreds. The plan which I adopt is as follows:—I place them, one or two at a time, in a shallow dish, and pour water over them until they are completely soaked or saturated with it. I then carefully pour off the water, and pour on to the prints a solution of chloride of lime (1 part liquor calcis chloratæ, to 39 parts of water). As a general rule, the stains disappear as if by magic, but occasionally they are obstinate. When that is the case, I pour on the spot pure liquor calcis chloratæ, and if that does not succeed, I add a little dilute nitro-muriatic acid. I have never had a print which has not succumbed to this treatment—in fact, as a rule they become too white. As soon as they are clean they must be carefully washed with successive portions of water until the whole of the chlorine is got rid of. They should then be placed in a very weak solution of isinglass or glue, and many collectors colour this solution with coffee-grounds, &c., to give a yellow tint to the print. They should be dried between folds of blotting-paper, either in a press or under a heavy book, and finally ironed with an ordinary flat-iron to restore the gloss; placing clean paper between the iron and the print. Grease stains are much more difficult. I find benzine best. Small grease spots may be removed by powdered French chalk being placed over them, a piece of clean blotting-paper over the chalk, and a hot iron over that." (F. Andrews.) (6) Mildew often arises from the paste used to attach the print. Take a solution of alum of medium strength and brush on back and face of the engraving 2 or 3 coats, then make the frame air-tight by pasting a strip of paper all round the inside of glass, leaving about ½ in. overlapping (taking care not to paste the paper on the glass, so as to be seen from the front), then place your glass in frame, take the overlapping piece and paste to side of rebate; place your picture in position, spring back board in, and then place a sheet of strong paper (brown) on the table, damp it, and paste round back of frame, lay it on to the paper, leave to dry, cut level. If this does not answer there will be no help for it, but dust off as the mould accumulates. Do not brush on surface with the alum if the engraving is coloured, but several coats on the back. (7) A plan recommended by Wm. Brooks is to get a dish or china tray a little larger than the engraving to be operated upon; if smaller, there is a great risk of tearing and damaging the engraving. The bleaching agent used is Holmes' ozone bleach. The strength preferred is 1 part bleach to 10 of water, well shaken up before pouring into the dish. A much stronger solution can be used (say 1 in 5), but the weaker it is the easier is its removal from the paper afterwards. The engraving is immersed in the solution face upwards, avoiding bubbles. The only caution to be observed is that the sodden engraving is somewhat rotten, and needs careful handling. If the engraving be only slightly stained, ½ hour will suffice to clean it, but if quite brown it may require 4 hours. After all the stains are removed, and the paper has regained its whiteness, pour the solution back into the bottle, as it can be re-used till it becomes discoloured; fill up the dish with water, changing frequently for about 3 hours, or place it in running water. When the engraving is sufficiently washed, it can be taken out, blotted off, and hung up to dry. When quite dry, it may be ironed on the back with a warm flat-iron, which must not be too hot. (*Brit. Jl. Photog.*) (8) If the engravings are very dirty, take two parts of common salt and one part common soda, and pound them together until very fine. Lay the engraving on a board, and fasten it with drawing-pins, and then spread the mixture dry equally over the surface to be cleaned. Moisten the whole with warm water and a little lemon-juice, and, after it has remained about a minute, or even less, tilt the board up on its end, and pour over it a kettleful of boiling water, being careful to remove all the mixture, and avoid rubbing. If the engraving is not very dirty, the less soda used the better, as it has a tendency to give the engraving a yellow hue.

Feathers.—(1) To clean feathers from their own animal oil, steep them in 1 gal. of water mixed with 1 lb. of lime, stir them well, and then pour off the water, and rinse the feathers in cold spring water. To clean feathers from dirt, simply wash them in hot water with soap. Rinse them in hot water. (2) To clean white ostrich feathers: 4 oz. white curd soap cut small, dissolved in 4 pints water, rather hot, in a basin. Make the solution into a lather by beating it with birch rods, or wires. Introduce the feathers and rub well with the hands for 5 or 6 minutes. After the soaping, wash in clean water as hot as the hand can bear. Shake until dry. (3) Slightly soften the soiled feathers with warm water, using a camel's-hair brush. Next raise each feather with a flat piece of wood or paper-knife, and clean them with spirits of wine. Dry with plaster-of-Paris, and afterwards brush them carefully with a dry camel's-hair brush. (4) Make a strong solution of salt in water, saturate a large and thick cloth with it. Wrap the bird up in the damp cloth in as many folds as you can, not disarranging the plumage. Look at the bird in 6 hours, and if not long dried on the blood will be soft; if not soft, keep it in the cloth longer, and re-wet it. When soft, rub out with gentle pressure, putting something hard under each feather with blood on, and rubbing with the back of a knife. Of course each feather must be done separately. (5) Col. Wragge treated the soiled plumage of albatrosses, Cape petrel, &c., by simply washing the feathers in rain water, after the process of skinning, and then laying a thick mixture of starch and water over the portion to be cleansed. Next he laid the birds aside, and left them till the plastering of starch had become thoroughly dry. He then removed the dry plaster by tapping it, and found that the feathers had become much cleaner. Old specimens may be cleaned in this way. Feathers may be "set" by just arranging them naturally with a needle or any pointed instrument. (6) *White.*—Dissolve 4 oz. of white soap in 2 qt. of boiling water; put it into a large basin or small pan, and beat to a strong lather with a wire egg-beater or a small bundle of birch twigs; use while warm. Hold the feather by the quill with the left hand, dip it into the soap liquor and squeeze it through the right hand, using a moderate degree of pressure. Continue this operation until the feather is perfectly clean and white, using a second lot of soap liquor if necessary. Rinse in clean hot water to take out the soap, and afterwards in cold water in which a small quantity of blue has been dissolved. Shake well, and dry before a moderate fire, shaking it occasionally that it may look full and soft when dried. Before it is quite dry, curl each fibre separately with a blunt knife or ivory paper-folder.

Coloured.—These are to be cleaned, and rinsed in warm and cold water, as above, but not rinsed in blue water. Coloured feathers may also be cleaned in a mixture of 1 part fresh gall and 3 of lukewarm water, washing them in this mixture in the same manner as in the soap liquor. But they will require more rinsing when done by this method, in order to take off all smell of the gall. Dry and curl as before.

Grebe.—Carefully take out the lining, and wash with warm water and soap, as directed for white ostrich feathers, but do not shake them until they are quite dry. Before re-making, carefully repair any rents there may be in the skin.

To purify Feathers for Beds, Pillows, &c.—Prepare a quantity of lime water in the following manner: Well mix 1 lb. of quicklime in each gal. of water required, and let it stand until all the undissolved lime is precipitated, as a fine powder, to the bottom of the tub or pan, then pour off the clear liquor for use. The number of gallons to be prepared will, of course, depend on the quantity of feathers to be cleaned. Put the feathers into a clean tub, pour the lime water on them, and well stir them in it until they all sink to the bottom. There should then be sufficient of the lime water to cover them to a depth of 3 in. Let them stand in this for 3 or 4 days, then take them out, drain them in a sieve, and afterwards well wash and rinse them in clean water. Dry on nets having a mesh about the same size as a cabbage net; shake the net occasionally, and the dry feathers will fall through. When they are dried, beat them well to get rid of the dust. It will take about 3 weeks to clean and dry a sufficient quantity for a bed. This process was awarded the prize offered by the Society of Arts.

Firearms.—(1) A good and simple way of cleaning and recolouring the barrels and other metal parts of a double-barrel shot gun which are quite rusty. Take the barrels from the stock, and put them in clean cold water free from gritty matters. Attach the brush to the washing rod, and get out all adhering powder and residues; next take tow and wash until the barrels are quite clean. If the parts have rusted, it will be necessary to use a little emery flour. Dry the barrels with clean cotton rags, rubbing until the metal feels warm. Plug the ports and muzzles securely, then cleanse the outside parts with a strong alcoholic solution of caustic potash, aided, if necessary, with a little emery flour and a soft rag. Rinse thoroughly in water, dry thoroughly, warm, and while warm rub over every part with the following preparation: pure (dry) zinc chloride 1 oz.; nitrate of antimony ¼ oz.; olive oil 2 oz.; well rubbed down into a smooth uniform paste. After ½ hour's exposure, rub off excess of this paste, and polish with clean soft rags. In warming the metal, avoid overheating it so as to injure the temper. (2) In the volunteer service there are several fluids used, which are composed of either turpentine, naphtha, petroleum, benzine, or gasoline, about one-third, or according to fancy, with Rangoon oil. But the instructions to the troops are—a damp rag, flannel or tow, is all that is required to clean the barrel out; if much water is used, it is liable to run into the action. The butt should be raised when washing out. After washing out and drying, an oily rag or flannel to be used. On many occasions the oily material will be found to be efficacious, without the previous use of water. (3) Easy method of cleaning guns and rifles when leaded.—If a muzzle-loader, stop up the nipple or communication hole with a little wax, or if a breech-loader insert a cork in the breech rather tightly; next pour some quicksilver into the barrel, and put another cork in the muzzle, then proceed to roll it up and down the barrel, shaking it about for a few minutes. The mercury and the lead will form an amalgam, and leave the barrel as clean and free from lead as the first day it came out of the shop. The same quicksilver can be used repeatedly by straining it through wash-leather; for the lead will be left behind in the leather, and the quicksilver will be again fit for use. (4) If the barrels have become leaded, wet the tow on the rod with spirits of turpentine, as the latter enjoys the property of removing any leading almost equally with quicksilver. Newark's gun-cleaning composition also answers admirably for this purpose, and prevents rust. Paraffin will also be found useful where neither of the foregoing can be obtained. Never touch the grooves of a rifle with emery, as it will dull their edges, and, consequently, affect the shooting power. (*Land and Water.*)

Floors.—(1) Take some clean, sifted, white or silver sand, and scatter it on the floor. Dissolve 1 lb. American potash or pearlash, in 1 pint of water, and sprinkle the sand with this solution. Have a pail of very hot water, and well scrub the boards lengthwise with a hard brush, and use the best mottled soap. Change the water frequently. This is the best way to scour and whiten boards. The potash, if applied as directed, will take out all stains. Ink stains may be removed from boards by using either strong vinegar, or salts of lemon. (2) The following will be found useful in cleaning and restoring colour to wooden floors:—1 part calcinated soda allowed to stand ¾ hour in 1 part slack lime, then add 15 parts water, and boil.

Spread the solution, thus obtained, upon the floor with a rag, and after drying, rub with hard brush and fine sand and water. A solution of 1 part concentrated sulphuric acid and 8 parts water will enliven the wood after above application. When dry, wash and wax the floor.

Fur.—(1) Soap or water will spoil it. Get some clean common whiting—powdered, and plenty of it—put it in a damp place for a day or so, but on no account let it get wet; rub it into the fur with the hand, and don't be afraid to rub it. Now let it stop till next day, give it another good rubbing, then shake out all the whiting you can, and give it a good brushing with a clothes-brush. It will now be pretty clean, except the skin at the bottom of the fur. To remove the dirt from thence get the fur over the back of a chair, and use the point of the clothes-brush very briskly, at the same time giving a short puff of wind every time you give a stroke with the brush. With a little patience you will remove every trace of whiting, grease, or dirt, Lastly, pour a little spirits of wine on a plate, dip the point of the clothes-brush in this, and lightly pass it over the fur; move the brush the same way as the fur runs. (2) Take equal parts of flour and powdered salt (which should be well heated in an oven), and thoroughly rub the fur. It should afterwards be well shaken, to free it from the flour and salt. (3) Lay the fur on a table, and rub it well with bran made moist with warm water. Rub until quite dry, and afterwards with dry bran. The wet bran should be put on with flannel, and the dry with a piece of book muslin. (4) Thoroughly sprinkle every part with hot plaster-of-Paris, and brush well with a hard brush. Then beat it with a cane, comb smooth with a wet comb, and press carefully with a warm iron; when dry, shake out all loose plaster-of-Paris.

Gas Chandeliers.—Very few chandeliers are gilt; they are burnished and lacquered with yellow lacquer. Proceed as follows, whether gilt or lacquered: Take the chandelier to pieces, and boil in strong soda ley for a few minutes, brush over with a soft brush, pass it through a strong solution of cyanide of potassium (a deadly poison), wash through a tubful of boiling water, dry in clean sawdust, wipe up bright with a washleather, and relacquer.

Gilt Mountings.—Gilt mountings, unless carefully cleaned, soon lose their lustre. They should not be rubbed; if slightly tarnished, wipe them off with a piece of Canton flannel, or, what is better, remove them if possible, and wash in a solution of ½ oz. of borax dissolved in 1 lb. of water, and dry them with a soft linen rag; their lustre may be improved by heating them a little, and rubbing with a piece of Canton flannel.

Gilt Picture Frames.—(1) Fly-marks can be cleaned off with soap and water used sparingly on end of finger covered by piece of rag. When all cleared off, rinse with cold water, and dry with chamois leather; next buy a pound (1*d.*) of common size, and 2 penny paint pans. Boil a little of the size in one of the pans with as much water as will just cover it. When boiled, strain through muslin into clean pan, and apply thinly to frames with camel-hair brush (called technically a "dabber," and costing 6*d.* to 1s. each). Take care you do not give the frames too much water and "elbow grease." On no account use gold size, as it is used only in regilding, and if put on over the gold would make it dull and sticky. (2) Dissolve a very small quantity of salts of tartar in a wine bottle of water, and with a piece of cotton wool soaked in the liquid dab the frames very gently (no rubbing on any account, or you will take off the gilt), then stand up the frames so that water will drain away from them conveniently, and syringe them with clean water. Care must be taken that the solution is not too strong. (3) If new gold frames are varnished with the best copal varnish, it improves their appear-

ance considerably, and fly-marks can then be washed off carefully with a sponge. The frames also last many times longer. It also improves old frames to varnish them with it. (4) Gilt frames may be cleaned by simply washing them with a small sponge, moistened with hot spirits of wine or oil of turpentine, the sponge only to be sufficiently wet to take off the dirt and fly-marks. They should not afterwards
e wiped, but left to dry of them-
lves. (5) Old ale is a good thing to
sh any gilding with, as it acts at
ce upon the fly-dirt. Apply it with
oft rag; but for the ins and outs of
ved work, a brush is necessary; wipe
nearly dry, and don't apply any water.
us will you leave a thin coat of the
tinous isinglass of the finings on the
e of the work, which will prevent
following flies' fæces from fastening
he frame, as they otherwise would

Glass.—(1) To clean glass in frames,
en the latter are covered or otherwise
finished that water cannot be used,
sten tripoli with brandy, rub it on
glass while moist, and when dry
off with a silk rag; to prevent the
ture injuring the cloth on the
use strips of tin bent to an
set these on the frame with one
n the glass; when the frames
of a character that will not be
ed by water, rub the glass with
r containing a little liquid am-
a, and polish with moist paper.
ass bottles.—(2) If vessels are oily
erwise greasy, they should not be
ed with water, but wiped with
tow, or a dry dirty cloth, so as to
ve as much grease as possible. By
ging the cloth for one that is clean,
essel can be wiped until all traces
ase disappear. (3) A strong solu-
f an alkali, such as pearlash, may
ed, whereby the removal of the
is materially facilitated. (4) If
be soiled by resin, turpentine,
rnishes, &c., it should be
a strong alkaline solution,
by means of the wire and
the alkali fail to act, a little sulphuric acid may be employed with advantage. The latter acid will also be found advantageous in removing pitch and tar from vessels of glass. Nitric or sulphuric acids may be employed to clean flasks which have contained oil. (6) A correspondent of the *Philadelphia Photographer* says:—"To clean a silver-bottle, pour in a strong solution of cyanide; shake a few times, pour out, and rinse with water 2 or 3 times, and your bottle is perfectly clean. Keep the solution, and filter and strengthen when required. By doing this you can sun your bath better in 2 hours than in a week's exposure in the dirty black bottles photographers appear to delight in." (7) It would be easy for a practical brushmaker to construct a brush, in the form of a hollow cone, which would reach the bottom of bottles; but the difficulty would be to get it into the bottle without spoiling it (the brush). A brush composed of a single bundle of long hairs (something like a painter's sash-tool) with the bristles cut somewhat tapering, should answer the purpose. The bottle must, of course, be turned round with the hand, to bring every part into contact with the brush. (8) Lead shot, where so used, often leaves carbonate of lead on the internal surface, and this is apt to be dissolved in the wine or other liquids afterwards introduced, with poisonous results; and particles of the shot are sometimes inadvertently left in the bottle. Fordos states that clippings of iron wire are a better means of rinsing. They are easily had, and the cleaning is rapid and complete. The iron is attacked by the oxygen of the air, but the ferruginous compound does not attach to the side of the bottle, and is easily removed in washing. Besides, a little oxidized iron is not injurious to health. Fordos found that the small traces of iron left had no apparent effect on the colour of red wines; it had on white wines, but very little; but he thinks it might be better to use clippings of tin for the latter. (9) Take a handful of common quicklime, such as bricklayers use, and a

handful of common washing soda; boil them in a large kitchen iron saucepan (which will only be cleaned, not damaged, by the process). When cold, the fluid will be soap lye; put this into the vessel you want to clean with some small pebbles or shot; make it warm if you can, and shake up or let it soak according to the nature of said vessel. (10) Glass vessels are cleaned with sand, or shot, which are objectionable. Gypsum without silicate, marble, bruised bones, are preferable. Sulphuric acid and bichromate mixed, are best to free porcelain and glass from organic matter. (*Eng. Mech.*)

(11) Glass bottles which have contained petroleum.—Wash with thin milk of lime, which forms an emulsion with the petroleum, and removes every trace of it; by washing a second time with milk of lime and a small quantity of chloride of lime, even the smell may be so completely removed as to render the vessel, thus cleansed, fit for keeping beer in. If the milk of lime be used warm, instead of cold, the operation is rendered much shorter. (*Ding. Pol. Jl.*)

Glass globes.—(9) Rub inside with a little wet pumice-powder on a cloth, and in 2 minutes you would not know that they were not newly purchased. The best way to cleanse dirty glass of all kinds is to put a small quantity of spirits of salts (hydrochloric acid) into a basin of water, and to place the dirty articles in the liquid for a few minutes, when it will be found that the glass is clean, and only requires drying. If very dirty, the globes may require to stay in the liquid a little longer. This plan is very useful for cleaning the pendant drops of glass chandeliers, water bottles, &c., as no soap is required. Care must be taken not to drop the undiluted spirits of salts on the clothes or hands.

Photographic glass plates.—(10) One of the most powerful—if not, indeed, *the* most powerful—detergents for refractory plates is the mixture of sulphuric acid and bichromate of potash recommended by Carey Lea some years ago. It is especially useful with glasses which have been frequently used, or which from the nature of the treatment they have undergone resist the action of both acids and alkalies completely. Its utility is dependent upon the powerful action of chromic acid upon organic matter, and we have never yet met with a plate which did not succumb to its treatment. One precaution is necessary in using it, however; it must be carefully removed from the glass by copious washing as soon as possible after it has done its duty. If allowed to soak for some time, as is frequently the practice, the plates appear to absorb the solution (the penetrating power of which is extraordinary), or an insoluble compound becomes firmly attached to the surface and stedfastly refuses to be displaced. Though generally invisible, it results in a peculiar mottled appearance between the glass and the developed film which entirely ruins the picture. We recently treated a number of plates which had become useless from this cause with various detergents, including acids as well as alkalies, but to no purpose; friction with various abrading powders failed to remove the defect, and we were well-nigh compelled to give it up. Remembering, however, that cyanide of potassium has been utilized by carbon printers for the purpose of reducing the strength of overprinted proofs—which it does by virtue of its action upon the insoluble compounds of chromium—we resolved to try its efficacy on our refractory plates, when all the mottling disappeared as if by magic. Those amongst our readers who dare to fly in face of all that has been lately written upon the dangers attending cyanide and bichromate of potash have here a "wrinkle." Surely those who have dared bichromate will not fear the minor dangers of cyanide. (*Brit. Jl. Phot.*) (11) A cream of tripoli powder and spirits of wine, with a little ammonia added, is a very good solution for cleaning glass plates. Old collodion is also very good; it should be thinned down with an equal bulk of spirits of wine; add an excess of iodide of potassium, and shake till the solution is saturated. Caustic potash is very good; so is carbonate of soda. If the plates be new, and covered with little gritty particles which do not come off on the application of potash, they may be removed with nitric acid. (12) Methylated spirits, washleather, and plenty of "elbow-grease." (13) At a recent meeting of the American Lyceum of Natural History, Dr. Walz suggested a method for cleaning greasy beakers and photographic glass plates, which must at once commend itself to all practical chemists and photographic operators. He takes a dilute solution of permanganate of potash, and pours in enough to wet the sides of the vessel to be cleaned. A film of hydrated manganic oxide is deposited, which is then rinsed with hydrochloric acid. Chlorine is formed, which acts in the nascent state on the organic matter, which becomes readily soluble. The permanganate solution can be used again and again till its oxidizing power is exhausted. (16) Dissolve 15 gr. of iodide of potassium in 5 oz. of water and 5 oz. of alcohol, afterwards adding 3 gr. iodine and enough whiting or rottenstone to make a creamy paste. Rub a little of this on the glass with a rag until clean, then polish with a cloth. (J. Hughes.)

Glass slides.—(14) "I had tried previously to remove the hardened balsam in many ways, and had succeeded fairly with a mixture of prepared chalk, methylated spirit, and liquid ammonia, but found this objectionable because it was such a dirty job. I now simply warm the slides over a flame, and push off the covers into strong sulphuric acid (oil of vitriol), and leave them therein for a short time; when clean, drain off, and rinse with a little fresh acid, and finish off by washing well in water. As much balsam as possible is removed from the slides by scraping with a knife, and then sulphuric acid is rubbed upon them with a glass rod. They are then well washed. If necessary, a finishing touch may be given with a warm solution of washing soda or methylated spirit and ammonia, to remove all trace of grease. Sulphuric acid should be added to water, or water to sulphuric acid, very gradually." (Thos. H. Powell.)

Paint stains on glass.—(15) American potash, 3 parts; unslaked lime, 1. Lay this on with a stick, letting it remain for some time, and it will remove either tar or paint. (16) Common washing soda dissolved in water. Let it soak a while—if put thick on say 30 minutes—and then wash off. If it does not remove, give it another application.

Glass windows. — (17) Procure a washleather of convenient size and some "paper-hanger's" canvas. Two yards, divided into three pieces, will be a nice size to work with. Have the cut sides hemmed, and they will last a long while. When it is desired, use one; boil or soak for an hour or so in a solution of soda and water to get out the "dress"; then wring out, and rinse in as many courses of clean water as you like; then partially dry (practice will enable you to judge), fold to a convenient size, and it will be ready for use. The soda solution will now be cool enough for the leather (if too hot it will shrivel the leather); wash in the same manner, and wring superfluous moisture out; then wash the glass thoroughly with it and plenty of elbow grease, and polish off with the canvas. (18) A very effective agent in cleaning glass is a dilute solution of fluoric acid. To this is sometimes added a small quantity of some other acid, either sulphuric or hydrochloric. The glass, after being washed with this, must immediately be well washed with clean water. Fluoric acid must be carefully handled, as before dilution it will cause painful sores if allowed to come in contact with the hands and to dry on them. It corrodes glass, which causes its cleansing power, so that the strong acid should not be kept in a glass or glazed bottle or jar, but in a bottle of guttapercha or similar material.

Gloves.—Kid.—(1) Make a strong lather with curd soap and warm water; lay the glove flat on a board, the bottom of a dish, or other unyielding surface: dip a piece of flannel in the lather and well rub the glove with it till all the dirt is out, turning it about so as to clean it all over. Dry in the sun or before a moderate fire. When dry they will look like old parchment, and should be gradually pulled out and stretched. (2) Have a small quantity of milk in a cup or saucer, and a piece of brown Windsor or glycerine soap in another saucer. Fold a clean towel or other cloth 3 or 4 times thick, and spread the glove smoothly on the cloth. Dip a piece of flannel in the milk, and rub it well on the soap. Hold the glove firmly with the left hand, and rub it with the flannel towards the fingers. Continue this operation until the glove, if white, appears of a dirty yellow; or if coloured, until it looks dirty and spoiled, and then lay it to dry. Gloves cleaned by this method will be soft, glossy, and elastic. (3) French method: Put the gloves on your hands and wash them in spirits of turpentine until they are quite clean, rubbing them exactly as if washing your hands; when finished, hang them in a current of air to dry and to take off the smell of the turpentine. (4) Eau de Javelle, 135 parts; ammonia, 8; powdered soap, 200; water, 150. Make a soft paste, and use with a flannel.

Washleather. — (5) Take out the grease spots by rubbing them with magnesia or with cream of tar. Then wash them with soap dissolved in water as directed for kid gloves, and afterwards rinse them, first in warm water and then in cold. Dry in the sun, or before the fire.

All gloves are better and more shapely if dried on glove trees or wooden hands.

Gold.—(1) To remove the brown tarnish from coloured gold, take a piece of tissue-paper damped in liq. ammoniæ, gently rub the gold till the tarnish disappears, then wash off carefully with soft brush, soap, and water, dry in sawdust or before the fire; if this is not sufficient, entrust the article to a jeweller. (2) Mix a little rouge and spirits of wine together, and apply to the jewellery with a rather stiff brush, and turn the brush round and round—not to brush as if to polish, but rather tickle it and pat it with the hair of the brush; but be sure to keep the brush wet with the mixture. After you have got the tarnish off, wash it out with soap and boiling water, and dry in box-dust. Take care of any stones with foil behind. (3) Rub with a piece of tissue-paper, screwed up and wet with the tongue. This will often do it; if not, re-colour it. (4) A weak solution of cyanide of potassium will clean gold braid. Use with small sponge, and wash off with clean water. Strength, say 10 or 15 gr. to the oz. of water. Care should be taken that the solution does not get into any cuts or wounds, as it is very poisonous. The strength of the solution would greatly depend on the condition of the lace. It can be made stronger if necessary. (5) A solution of 20 dr. chloride of lime, 20 dr. bicarbonate of soda, and 5 dr. common salt, in 5¼ pints distilled water, is prepared and kept in well-closed bottles. The article to be cleaned is allowed to remain a short time in this solution (which is to be heated only in the case of very obstinate dirt), then taken out, washed with spirit, and dried in sawdust. (*Chem. Cent. Blatt.*)

Iron and Steel.—(1) Take a spongy piece of fig-tree wood and well saturate it with a mixture of sweet-oil and finely powdered emery, and with this well rub all the rusty parts. This will not only clean the article, but will at the same time polish it, and so render the use of whiting unnecessary. (2) Bright iron or steel goods (as polished grates and fire-irons) may be preserved from rust in the following manner. Having first been thoroughly cleaned, they should be dusted over with powdered quicklime, and thus left until wanted for use. Coils of piano-wire are covered in this manner, and will keep free from rust for many years. (3) Dissolve ½ oz camphor in 1 lb. hog's lard, and take off the scum; then mix with the lard as much black-lead as will give the mixture an iron colour.

Rub the articles all over with this mixture, and let them lie for 24 hours; then dry with a linen cloth, and they will keep clean for months. (4) Table knives which are not in constant use should be put in a case containing a depth of about 8 in. of quicklime. They are to be plunged into this to the top of the blades, but the lime must not touch the handles. (5) Steel bits that are tarnished, but not rusty, can be cleaned with rottenstone, common hard soap, and a woollen cloth.

Ivory and Bones.—(1) The curators of the Anatomical Museum of the Jardin des Plantes, in Paris, have found that spirits of turpentine is very efficacious in removing the disagreeable odour and fatty emanations of bones or ivory, while it leaves them beautifully bleached. The articles should be exposed in the fluid for 3 or 4 days in the sun, or a little longer if in the shade. They should rest upon strips of zinc, so as to be a fraction of an inch above the bottom of the glass vessel employed. The turpentine acts as an oxidizing agent, and the product of the combustion is an acid liquor which sinks to the bottom, and strongly attacks the ivory if allowed to touch it. (2) Make a thick puddle of common whiting in a saucer. Brush well with a tooth-brush into the carved work. Brush well out with plenty of clean water. Dry gently near the fire. Finish with a clean dry hard brush, adding one or two drops (not more) of sweet oil. (3) Mix about a tablespoonful of oxalic acid in ½ pint of boiling water. Wet the ivory over first with water, then with a tooth-brush apply the acid, doing one side at a time, and rinsing; finally drying it in a cloth before the fire, but not too close. (4) Take a piece of fresh lime, slake it by sprinkling it with water, then mix into a paste, which apply by means of a soft brush, brushing well into the interstices of the carving; next set by in a warm place till perfectly dry, after which take another soft brush and remove the lime. Should it still remain discoloured, repeat the process, but be careful neither to make it too wet nor too hot in drying off, or probably the article might come to pieces, being most likely glued or cemented together. If it would stand steeping in lime-water for 24 hours, and afterwards boiling in strong alum-water for about an hour and then dried, it would turn out white and clean. Rubbing with oxide of tin (putty powder) and a chamois leather, will restore a fine gloss afterwards. (5) Well clean with spirits of wine, then mix some whiting with a little of the spirits, to form a paste, and well brush with it. It is best to use a rubber of soft leather where there are no delicate points; put a little soap on the leather, and dip into the paste and rub the ivory until you get a brilliant polish, finish off with a little dry whiting; the leather should be attached to a flat wood surface, and rub briskly. (6) When ivory ornaments get yellow or dusky-looking, wash them well in soap and water, with a small brush to clean the carvings, and place them while wet in full sunshine; wet them two or three times a day for several days, with soapy water, still keeping them in the sun; then wash them again, and they will be beautifully white. To bleach ivory, immerse it for a short time in water containing a little sulphurous acid, chloride of lime, or chlorine.

Leather.—(1) Carriage tops that have faded and become grey can be restored by washing with a solution composed of 4 oz. of nut galls, 1 oz. each of logwood, copperas, clean iron filings, and sumach berries; put all but the iron filings and copperas in 1 qt. of the best white wine vinegar, and heat nearly to the boiling-point; then add the copperas and iron filings; let them stand for 24 hours, and strain off the liquid; apply with a sponge. This is equally good for restoring black cloths. (2) Enamelled leather tops that have been soiled by dust and rain should be washed with soft water and Castile or crown soap. Apply the water with a sponge and then scrub with a moderately stiff brush; cleanse with clean water and dry with a "shammy." Never apply any kind of oil or top dressing without first cleaning the leather. (3) To clean mouldy leather, remove the surface mould with a dry cloth, and with another cloth apply pyroligneous acid. (4) To clean russet leather-covered mountings, remove all stains and dirt by rubbing the leather with a cloth and a little oxalic acid, and restore the colour and finish by the use of salts of lemon, applied with a woollen cloth. Rub the leather until a good polish is produced. (5) To clean rubber-covered mountings, rub the covered as well as the metallic parts with a "shammy" and a little tripoli, and finish with a clean woollen cloth. (6) To clean a soiled chamois-leather, make a solution of weak soda and warm water, rub plenty of soft soap into the leather, and allow it to remain in soak for 2 hours, then rub it well until it is quite clean. Afterwards rinse it well in a weak solution composed of warm water, soda, and yellow soap. If rinsed in water only, it becomes hard when dry, and unfit for use. The small quantity of soap left in the leather allows the finer particles of the leather to separate and become soft like silk. After rinsing, wring it well in a rough towel, and dry quickly; then pull it about and brush it well, and it will become softer and better than most new leathers. (7) To clean morocco leather, strain well over a board, and scour with stiff brush, using tepid water and soft-soap, made slightly acid with oxalic acid; when done, unstrain the leather, and dry in a cool place; do not saturate the leather, but keep the board inclined; when dry, rub a little oil lightly over the surface with a rag. (8) *To clean riding saddles.* If much soiled, wash the leather with a weak solution of oxalic acid and water, and, when dry, with the watery portion of beef blood. The latter can be preserved by adding a little carbolic acid, and keeping it in a bottle tightly corked. (9) Brown saddles may be cleaned to look as well as new by the use of tepid water and crown soap; if the latter cannot be had, use pure Castile soap.

Marble.—(1) Take finely powdered pumice-stone and vinegar, wash the surface with the mixture, and leave it for several hours, then brush it hard and wash it clean. When dry, rub it with whiting and washleather. (2) Equal parts of caustic potash, quick-lime, and soft-soap; make into a thick paste with water, and apply with a brush; leave for about a week, and apply again and again until the stain has disappeared. (3) 2 parts soda (carbonate), 1 of pumice-stone, and 1 of finely powdered chalk. Mix into a fine paste with water. Rub this over the marble, and the stains will be removed; then wash with soap and water. (4) Wash the marble thoroughly with soda and warm water to remove any grease, and apply oxalic acid by laying a piece of white cotton cloth saturated upon the spots for a short time. If it destroys the polish, repolish with oxide of tin and water applied with a cloth. If the stains are not deep, rub the surface only with the oxalic acid and water upon a small piece of cloth quickly, and wash, to free the marble of acid. Then, to give it a gloss, rub with chalk wet with water. (5) Marble figures may be washed clean by putting them out in a heavy shower.

Mirrors.—(1) Wet the surface of the glass with gin, to remove the stains. Then rub with a cloth dipped in powdered blue. Polish with a silk handkerchief. Be very careful not to touch the frames. (2) Very soft paper is much better than cloth.

Oilcloth.—Wash with a large, soft, woollen cloth and lukewarm or cold water, dry thoroughly with a soft cloth, and afterwards polish with milk, or a weak solution of beeswax, in spirits of turpentine. Never use a brush, or hot water, or soap, as either will be certain to bring off the paint.

Paint.—(1) Dissolve ½ oz. glue, and a bit of soft-soap the size of a walnut, in about 3 pints of warm water, and with a well-worn whitewash brush well scrub the work, but not sufficient to get off the paint, and rinse with plenty of cold clean water, using a washleather; let it dry itself. Work done in this manner will often look equal to new. (2) First take off all the dust with a soft brush and pair of bellows. Scour with a mixture of soft-soap and fullers' earth, and use lukewarm water. If there are any spots which are extra dirty, first remove these by rubbing with a sponge dipped in soap and water. Commence the scouring at the top of the door or wainscot, and proceed downwards; and dry with a soft linen cloth. When cleaning paint, it is always better to employ two persons, one to scour and the other to rub dry.

Paint-brushes. — To soften brushes that have become hard, soak them 24 hours in raw linseed oil, and rinse them out in hot turpentine, repeating the process till clean; or wash them in hot soda and water and soft-soap.

Paintings.—(1) Dissolve a little common soda in urine, then add a grated potato and a little salt; well rub this over the paintings till clean. Wash off in spring water, and dry with a clean cloth. (2) First rub the picture well with good whisky, which will make the varnish come off in froth, then wash well with cold water, and when dry varnish again; this will restore the picture to its original colour unless very old. Keep the picture covered from dust till the varnish is dry.

(3) Elfred Blaker's process of restoring oil paintings is thus described in *Scientific Industries Explained*:—The process may be divided into 4 heads: (1) Lining, (2) Stopping, (3) Cleaning, (4) Stippling or restoring proper.

Lining.—A strong wooden frame, called a "stretcher," is made of stout "quartering" of the size required, and fitted with wedges (as in ordinary canvas "strainers"), by means of which the frame may be slightly extended so as to tighten or stretch a layer of canvas spread over and secured to it by means of tacks. Take ordinary picture-liner's canvas, several inches wider each way than the picture to be lined, and tack it on to the frame. The canvas being strained or stretched, the back of the picture is carefully brushed over with a mixture composed of glue and "size," the face of the canvas being also brushed over with the same mixture. The picture is next laid back downward on the canvas, beginning at one corner and gently pressing it with the hand so as to disperse air-bubbles. The canvas is tightened by driving in the wedges at each corner of the stretcher. Take as many sheets of double-crown paper as will cover the entire picture (allowing each sheet to overlap the other about 1 in.); brush paste over one side of each sheet and fold separately. When the required number of sheets of paper have been thus prepared, take the first sheet, open it, and lay it carefully on the picture, beginning at one corner, and press it as before with the hand so as to remove air-bubbles. Each sheet is to be laid on in the same way until the entire picture is covered. After being left for a time, and when the paper is dry, the picture is subjected to pressure from a heavy heated iron, somewhat resembling a tailor's goose. For this purpose a perfectly smooth board, equal in thickness to the timber with which the stretching frame is made, is placed beneath the picture, at one corner, and the heated iron (the temperature of which must not be too high) is thus applied with steadiness and care, the pressing-board being shifted (when a large picture is under treatment) until the whole surface of the picture is well pressed. When the canvas is perfectly dry, the paper is removed by a sponge and warm water. When all traces of paper and paste are removed from the surface of the picture, the latter is removed from the rough stretcher, the canvas neatly trimmed, leaving sufficient margin to attach it to a new strainer of a size suitable to the picture; the canvas margin is then tacked on to the edge of the frame in the usual way, after which the wedges are driven tight.

Stopping.—The object of this operation is to fill all fissures or cracks in the picture with a composition which is capable of receiving a coating of paint without absorbing it. The composition employed for this purpose consists of a mixture of size and whiting, to which a small quantity of black is added to give the composition a neutral tint. The "stopping," as this mixture is called, is pressed into the cracks by means of a palette-knife, care being taken that every fissure is well filled with it. The picture must now be set aside for several days to allow the stopping to become gradually but thoroughly dry. The next operation is to remove the superfluous stopping, which is effected by rubbing the surface of the picture with soft or "velvet" cork moistened with water. The cork must be applied gently and with a circular motion, so that, while removing the superfluity, the cracks may be left perfectly level.

Cleaning.—This term is applied technically to the removal of varnish from old pictures, and it is scarcely necessary to say that if this were attempted by means of chemical solvents of gum-resins, which form the basis of most varnishes, old or new, the operation would be very hazardous in skilful hands, while in those of an ignoramus the underlying picture would (as has frequently been the case) be sacrificed, by the solvent (turpentine, for example), after attacking the varnish, performing the function of dissolving the oil of the picture. This barbarous application of varnish solvents has acquired the appropriate name of "skinning," a term which implies the removal not only of the varnish, but the picture itself. Although it is possible by means of chemical solvents to remove coats of varnish from the surface of oil paintings, the plan adopted by Blaker is by far the most safe, and in practical hands the most secure. It consists in rubbing the varnished surface gently with the finger, by which the resinous matter works up into a powdery condition, and this action is kept up with great care until the colours of the picture, as will be readily understood, become exposed to view.

Restoring.—When it is borne in mind that the varied tints and colours employed by the old masters (and many of which are of doubtful origin at the present day) require to be faithfully matched, it will be understood that only an artist of great skill and experience, possessing an extensive knowledge of the productions of the old painters, should be entrusted with the delicate operation of renovating, without spoiling, works of olden time. The process called "stippling" is adopted for matching the various colours and tints, very small brushes being employed, and each brush being reserved for its special use with great care, in order to avoid even the most trifling risk of mismatching any required tint. When the stippling has thus been done by an artist possessing knowledge and experience, as well as natural ability (the two first-named attributes being the most essential), the picture, when "restored," and subsequently varnished, presents the appearance of a perfect picture, the touches of the restorer being imperceptible. Before the picture is varnished, strips of white paper about $1\frac{1}{2}$ in. wide are neatly pasted round the edge of the frame, and overlapping the picture about $\frac{1}{8}$ in., so as to leave a neat but scarcely perceptible margin. The varnishing of oil paintings is more properly effected by skill than by rule of thumb. The operation should be conducted in a warm room, perfectly free from dust. The picture should be laid flat on a level bench, and a small quantity of varnish poured on its centre; a flat soft brush is then taken, and with this the varnish is brushed over the surface, care being taken to avoid "brush-marks." The picture is then allowed to remain in its horizontal position until the varnish is thoroughly dry.

(4) Radlkofer, of Munich, proved some time since, by microscopic observation, that the deterioration of the works of art hung in the Pinacotheca of Munich and in the galleries of Schleissheim was not due, as had been suspected, to any organized matter.

Pettenkofer succeeded in tracing the cause of the mischief; and Goppelsröder, Director of the Municipal School of Industrial Chemistry at Mulhouse, made a report on the subject to the Industrial Society of that town, declaring Pettenkofer's theory and mode of proceeding fully confirmed. The following are Pettenkofer's theory and modes of operation:—Linoleine (the linoxine of Mulder) is the principle of the greater portion of the oils used by artists, but, unfortunately, this principle cannot be prepared in a pure state, and painters are compelled to employ either linseed oil, which contains 80 per cent. of linoleine, or poppy oil, which only contains 75 per cent. Linoleine, which, when pure, is liquid, solidifies by oxidation, on contact with the air, without decrease in volume, but with an increase of 10 per cent. in weight. It is because linoleine acquires an unvariable consistency in any temperature that colours, after a picture is dry, are not affected by moderate pressure, by fatty or ethereal oils, nor by varnishes. Paintings absorb moisture from the atmosphere, and afterwards allow it to evaporate. After a longer or shorter period when these successive absorptions and evaporations of moisture have been pretty often repeated, the colour laid on by the artist generally has lost its primitive aspect, and ceases to produce the same optical effect.

As to the means employed previous to the discoveries of Pettenkofer for the regeneration of the physical condition of the colours, it must be remembered that the artist himself varnishes his dry picture to fill up the pores, which during the work contained oil, but which after the picture is dry contain only air and varnish. He employs resinous oil, solutions of resin in essence of turpentine or in fatty and drying oils. These last are very dangerous. After a certain time the varnish perishes and no longer allows the light to pass through it; new varnish is applied, and the operation is repeated unfortunately until all brilliancy is destroyed. To repair the evil, there are no other means but the removal of the varnish, the nourishing of the colour with a fresh coat of oil, and, after drying, to apply a new coat of varnish, to say nothing of brushwork. When the restoration is made by moistening the varnish with water, the effect after drying is a white spot wherever the water has been applied.

Pettenkofer has shown that paintings are constantly liable to those successive condensations and evaporations mentioned above, which cause loss of cohesion of the varnish. He has, moreover, succeeded in re-establishing the molecular cohesion by means of the vapour of alcohol mixed with the air; at the end of 48 hours the resin takes up and condenses 80 to 100 per cent. of its own weight of alcohol, which, however, it loses again after a short time. The resin, thus softened, becomes absorbed by the painting, and by the same act the cohesion of the resin and the colour is re-established. Softened resin has less effect on the colours of a painting than varnish applied with a brush, for the friction of the latter may cause displacement of the colouring bodies.

Pettenkofer's plan is simple; in the first place he makes a small experiment on the painting to be restored, by means of a small round box made of cardboard, the inside of which is dressed with glue and the bottom lined with flannel moistened with alcohol at 80°; the picture is freed from dust, and the box turned down upon a part of it. The spot thus restored serves as a guide for the general restoration of the work, which is done by fixing the picture to the lid of a box, the bottoms and sides of which are lined with flannel moistened with pure alcohol, as above described, and shutting very closely, so that a small quantity of alcohol serves for a series of pictures.

A second method, indicated by Pettenkofer, consists in the use of the balsam of copaiba, which dries very slowly, and which resembles in constitution the varnishes composed of dammar or mastic dissolved in essence of turpentine. The copaiba should have the consistency of unboiled oil, but must not contain oil, resin, or essence of turpentine. The essential oil of the balsam of copaiba is less volatile in ordinary temperatures than the essence of turpentine. The balsam of copaiba fulfils well the optical conditions of the ordinary resinous varnishes, and may be applied to certain parts only of a picture without being perceptible; it fills up the pores which have been produced in the coloured parts, and sometimes this object may even be effected by applying the balsam to the back of the canvas. The application of copaiba and the vapours of alcohol has in many cases to be repeated several times, and they may cause the appearance of cracks previously invisible, in which case it is only necessary to rub them with a small quantity of the balsam, and expose them to the vapour of alcohol.

If there be an excess of resin, and above all, if the pictures become too yellow in tone, it is absolutely necessary, unfortunately, to remove that excess, but without injuring the primitive character of the colour, before commencing the restoration proper. The varnish, however, can never be entirely removed without some slight deterioration of colour, because the resin is not only superposed but incorporated with the colour.

To remove the excess of resin, either rub with the finger dipped in powder of colophony, or dissolve it with essence of turpentine; and, on the other hand, to fill the pores of the picture with resin, first wash with water, and then with essence of turpentine, and having nourished it, as it were, with balsam of copaiba, the part is made to swell by the application of vapour of alcohol.

If the picture contain both resinous and oil varnishes, the former alone takes up alcohol, becomes softened and retires into the colours, while the latter remains on the surface, and renders it dull and even rough. In this case only the balsam of copaiba is used, and smoothness of surface is obtained by pressure.

A painting regenerated by means of balsam of copaiba resists for a long time the influence of the condensation and evaporation of humidity.

(5) A correspondent of the Philadelphia *Evening Bulletin* has taken the pains to find out how the galleries and the pictures in the Louvre are kept clean. On Mondays the palace is closed; it is then that the weekly cleaning takes place. The first thing done is to cover the floor with damp sawdust to the depth of an inch or so. Oak sawdust is used for the boards, and elm dust for the marbles. This is allowed to remain some time, and is then removed, and with it goes every particle of dust or dirt which may have adhered to the floor. Then the men buckle on to their feet large stiff brushes, and, armed with a stout stick, to one end of which is fastened a great piece of prepared beeswax, they first rub the floor with wax, then skate over it with their brushes, and finally give it the finishing polish with a great woollen cloth made expressly for this purpose. The same cloth is passed daily over the floor before the opening of the museum, which is all that is required until the following Monday. In this way no dust arises, and the pictures need rarely to be cleaned. When this becomes necessary, which happens about once in 4 or 5 years, the museum is closed for several days. No one is allowed to touch a picture unless the "Conservateur du Musée" be present. The pictures are taken down, and it is the "Conservateur" himself who places a thick sheet of clean wadding over the painting, pressing it down gently in such a way that every particle of dust adheres to the wadding. After this is done, a thin coat of oil or some mixture which replaces it is rubbed on, and the picture is not again touched until the next general house cleaning.

(6) **Parchment.**—Immerse the parchment in a solution of acetic acid, and gently rub the stained parts while wet on a flat board with lump pumice, then bleach it with chloride of lime. This process was recommended in the *English Mechanic.* It is not very suc-

cessful, but it makes it white enough for bookbinding. It has, however, the objectionable qualities of not making the parchment flexible, and when dried it is as hard as a board, and it has no gloss like the virgin parchment. On no account must the parchment be washed in very hot water, or held before a fire, as it will shrivel up in a most provoking manner.

Sheepskin Mats.—Wash while fresh in strong soapsuds, first picking from the wool all the dirt that will come out. A little paraffin, 1 tablespoonful to 3 gal. water, will aid in removing the impurities. Continue to wash the skin in fresh suds till it is white and clean. Then dissolve ½ lb. each of salt and alum in 3 pints boiling water, put into it water enough to cover the skin, which should soak in the solution 12 hours, and then be hung on a line to drain. When nearly dry, nail it, wool side in, on a board, or the side of a barn, to dry. Rub into the skin 1 oz. each of pulverized alum and saltpetre, and if the skin is large double the quantity. Rub for an hour or two. Fold the skin sides together, and hang the skin away for 3 days, rubbing it every day or till perfectly dry. Then with blunt knife clear the skin of impurities, rub it with pumice or rottenstone, trim it into shape, and you have a door mat that will last a lifetime. If it is to be dyed, have a shallow vessel as large as the skin in which to prepare the dye, so that the skin can be laid wool-side down smoothly into the vessel that all parts may be equally immersed in the dye. This should not be more than an inch deep, otherwise the skin might be injured by the hot dye. After colouring, again stretch the skin to dry, and then comb with a wool or cotton-card.

Silver.—(1) East Indian jewellers never touch silver ware with any abrasive substance, but use, instead of polishing paste, &c., slices of lemons; the goods to be cleaned are well rubbed with these, and then left in a pan for a few hours, covered with slices. For delicate jewellery, a large lime is cut in half, the article inserted, the two halves applied together and tied up for some hours; the article is then washed in several waters, placed in a pan of nearly boiling soapsuds, stirred about, rinsed, and dried on a metal plate, the smooth parts being gently rubbed with washleather, if required. Cyanide of potassium solution (rather weak) dissolves off the dirty surface gradually, but great care is required. Green tamarind pods (oxalate of potash) are greater detergents for gold and silver than lemons, and are often employed for the purpose of removing stains, fire-marks, &c. (*Boston Journal of Chemistry.*) (2) Elsner states that a polish equal to that obtained by the use of the finest plate powder, can be produced by simply cleaning the silver in water in which potatoes have been boiled. (3) Dead or engraved silver goods should never be cleaned with plate powder, but be washed out with a soft brush and some strong alkali, and well rinsed afterwards. When the dead or frosted parts are quite dry, the polished parts are carefully cleaned with powder. (4) The following directions are given by a silversmith in Christiania:—Silver filagree work is best cleaned by the application of spirit of ammonia by means of a soft brush, and afterwards thoroughly washing in soft-soap and warm water, and rinsing in clean warm water, and quick drying by linen rags, blotting-paper, or some similar clean absorbent. Should this method, after several repetitions, cease to have the required effect, the article will have to be sent to a silversmith to be heated and boiled in acid. The best mode of preservation is to wrap the article in tissue paper before placing it in the case. (5) The simplest and cleanest substance for cleaning silver articles is, according to Professor Davenport, hyposulphite of soda. It acts quickly, and is inexpensive. A rag or a brush, moistened with a saturated solution of the salt, cleanses even strongly oxidized silver surfaces in a few seconds, without the application of any polishing powder. (6) Mix 8 oz. prepared chalk, 2 oz. turpentine, 1 oz.

alcohol, 4 dr. spirits of camphor, and 2 dr. liquor of ammonia. Apply this mixture to the article with a sponge, and allow to dry before polishing. (7) Dissolve 12 oz. cyanide of potassium in 1 qt. of water; dip the silver in this solution, and brush it with a stiff brush until clean, then wash and dry.

(8) Tarnished silver lace. Sponge over with a weak solution of potassium cyanide. (9) Dab over with a cream of heavy magnesia and water, allowing this to dry, and then brushing it off with a soft-haired brush.

Sponge.—(1) A sponge employed in photographic manipulations for a few months loses all its valuable qualities, becoming black, hard, and greasy, and contaminating anything which it touches. To clean it, a solution of permanganate of potash in water is prepared of such a strength that it appears of a wine colour, and into this the unserviceable sponge is immersed, and allowed to remain for some time. When taken out and squeezed, it is next put into a diluted muriatic acid of ordinary commercial quality, being immersed and kept saturated therein for some time as before. The most appropriate strength of this acid solution is about 10 parts water to 1 of acid. The sponge is taken out after sufficient treatment, squeezed well to free it from the acid, and then washed well in good spring water. When taken out, it will be found to be quite clean, to have again assumed its light colour, and to be free from all foreign matter. Sponges treated in this way become like new sponges, and can be used without any fear of their contaminating, even if employed for the filtration of neutral liquids. The main thing to be attended to in this plan of purifying sponge is to see that it is thoroughly saturated both by the permanganate and the acid solutions, which should be allowed ample time to soak through the mass; care must also be observed to wash the sponges thoroughly with plenty of water at the end of the operation. (Dr. J. Stinde.) (2) When sponges get greasy, let them dry, and then work them with a small quantity of turpentine, and after a few minutes wash them with warm soap-and-water with a little bit of soda. This will get them quite clean with very little trouble. (E. T. Scott.) (3) Put a handful of salt on the sponge, and rinse the salt well through the sponge. Let the sponge dry in a thorough draught of air. The latter precaution alone will keep sponges free from sliminess, unless they become saturated with soap. (4) I tried the effect of sulphuric acid as follows:—In a large basin mixed about a pint of water and two tablespoonfuls of sulphuric acid (common oil of vitriol), then steeped the sponge about 2 hours, wrung it out several times in the acid, and finally well washed out the acid in clean water; it was then just like new, having regained its former size, colour, and elasticity, with not the slightest trace of its former sliminess. It was a large bath-sponge, and in an extremely bad condition. (J. W. Jackson.) (5) Dissolve some citric acid in water in a hand-basin, and wash the sponge in it as in (4).

Stains, removing.—The following general remarks on the removal of stains appeared anonymously in the *English Mechanic.* To proceed with any degree of certainty in endeavours to remove stains, they must be divided into three classes, as each variety will require a peculiar treatment. The first class comprehends those stains which do not in any way affect the nature of the material or colour, but simply alter its appearance, and which can be removed by the application of one agent alone. These may be designated Simple Stains. The second division includes such as are produced by two or more substances conjointly, and which consequently require the employment of several cleaning agents. These are known as Mixed Stains. In the third category may be placed such stains as are produced by bodies which alter or destroy the colour.

In the first class are *water*, *oily matters*, *vegetable juices*, *blood*, and *iron* or *ink* stains. If water be allowed to fall on some kinds of silks, satins, or woollen fabrics, it dissolves away part of the dressing, and the consequence is that a dull spot appears on the glossy ground. To remove a stain of this nature, it is necessary to steam the spotted material until it is all equally moistened. It may then be hot-pressed, or, if small, ironed with a hot, but perfectly clean iron.

Grease spots may generally be removed from the most delicate material by the employment of benzine or oil of turpentine, care being taken that sufficient be employed to remove all line of demarcation. Ox-gall is particularly useful in extracting grease stains from woollen goods. If the stain be very thickly crusted and old, it may be sometimes advantageous to soften the grease (previous to the application of benzine) by means of a warm iron laid on a piece of thick blotting-paper which has been placed over the spot.

Tar and *pitch* produce stains easily removed by successive applications of spirits of turpentine, coal-tar naphtha, and benzine. If they are very old and hard, it is as well to soften them by lightly rubbing with a pledget of wool dipped in good olive-oil. The softened mass will then easily yield to the action of the other solvents.

Resins, varnishes, and *sealing-wax* may be removed by warming and applying strong methylated spirits. Care must always be taken that, in rubbing the material to remove the stains, the friction should always be applied the way of the stuff, and not indifferently backwards and forwards.

Most *fruits* yield *juices* which, owing to the acid they contain, permanently injure the tone of the dye; but the greater part may be removed without leaving a stain, if the spot be rinsed in cold water in which a few drops of liquor ammonia have been placed *before the spot has dried. Wine* also leaves an ugly stain on white materials; from these it may be removed by rinsing with cold water, applying locally a weak solution of chloride of lime, and again rinsing in an abundance of water. The dressing must again be imparted by steaming, starching, and hot-pressing.

Fresh *ink* and the soluble salts of iron—such as are used by photographers in their developing solutions, &c.—produce stains, which, if allowed to dry, and especially if afterwards the material has been washed, are difficult to extract without injury to the ground. When fresh, such stains yield rapidly to a treatment with moistened cream of tartar, aided by a little friction, if the material or colour is delicate. If the ground be white, oxalic acid, employed in the form of a concentrated aqueous solution, will effectually remove fresh iron stains. *Acids* produce red stains, on blacks, blues, and violets, made from the vegetable colours (except indigo). If the acid has not been strong enough to destroy the material, and the stains are fresh, the colour may generally be restored by repeated soakings in dilute liquor ammonia, applied as locally as possible. Photographers frequently stain their clothes and cloths with *nitrate of silver*. The immediate and repeated application of a very weak solution of cyanide of potassium (accompanied by thorough rinsings in clean water) will generally remove these without injury to the colours.

Mixed stains are generally produced by spilling sauces, gravy, or, by inadvertently rubbing against wet paint, cart-grease, gome, &c. *Sauce* usually contains oily or greasy matter, blood and vinegar, or some fruit-juice; hence the first step consists in removing the grease by means of ox-gall or benzine, then the acid of the vinegar or juice is neutralized by means of weak ammonia, when a final rinse in cold water will extract the blood, &c.

Most *fruit-juices, wines, jam,* &c., leave stains that will require a preliminary washing with water, to remove sugary matter, treatment with very dilute ammonia to neutralize the acid, and exposure while damp to the fumes of burning sulphur. But the action of this agent must be localized as much as possible to the spot where the stain occurs, and it must be used with the greatest circumspection, for it bleaches nearly all vegetable colours, though many of them regain their force on exposure to air.

Paint stains may be treated with oil of turpentine to remove the oil, with oxygenated water to oxidize the lead, and finally, with dilute acetic acid. If the paint contains oxide of iron, oxalic acid will have to be used, while the copper colours must be treated with liquor ammonia.

Old *ink* stains require treating first with protochloride of tin, to deoxidize the iron, and then with dilute oxalic acid. If the material be white, it may be touched with a dilute solution of chloride of lime on the part stained, and then thoroughly washed.

Lubricants generally contain, besides grease, oxide of iron worn off the machinery, &c., hence the grease must first be extracted by means of benzine, ox-gall, ammonia, &c., and then the spot treated with oxalic acid or chloride of lime water, or even lemon-juice, if the material is very delicate. Rinsing must always follow the application of these agents.

Mercurial ointment produces very persistent stains. These may be extracted by washing the spot with a hot solution of soda (1 soda to 50 water), and when the grease is removed, by rubbing over with a rather strong solution (clear) of chloride of lime. Benzine must be substituted for the soda solution if the article is coloured or delicate.

Care must be taken in all these cases to operate on both sides of the stuff, or the removal will only be superficial, and the spot will reappear in time. It will be seldom found, in the case of mixed stains, that the original tone of the colour is not more or less altered or injured. Consequently, attempts must be made to re-establish the colours. If the colours be aniline, the application of Judson's dyes, in a dilute form, will generally be efficacious, except on cottons, which will require a previous mordanting on the spot. This may be effected by means of a strong decoction (clear) of myrobalams.

If the colours have been changed by vegetable acids, or dilute mineral acids, the colour may generally be restored by means of dilute ammonia. If that does not suffice, the spot must be mordanted with a brush, and the dye painted in. While drying, the spot must be continuously rubbed with a pledget of wool dipped in ether, so as to spread the matter equally, and leave no sharp line of demarcation. A weak solution of sulphate of indigo will be found useful for restoring blues; the strength must naturally be proportioned to the depth of tone required. Most scarlets, crimson, &c., can be restored by the application of a solution of bichloride of tin, followed, if necessary, by a local application of tincture of cochineal. If crimson be required, a small portion of alum must be added; if scarlet, cream of tartar along with the cochineal.

The stains produced by fresh *urine*, and by *perspiration*, require to be treated first with weak ammonia, and then with the bichloride of tin solution (long known as eau écarlate), which will, if the colour be not altogether destroyed, restore it. Painting in, after the application of the appropriate mordant, is the only remedy, if the colour has suffered permanently.

Aniline Colours.—(1) Goods stained with aniline colours may be rendered clean by the use of zinc grey: the metallic zinc contained in this powder reduces the colours, forming soluble colourless products. Triturate 100 gr. zinc grey with 50 gr. mucilage, 20° B., until the mixture is homogeneous; incorporate with this 20 gr. of a solution of hyposulphite of soda, 20° B., apply this mixture directly to the goods; let it dry and vapourize. After this operation it is best to wash the goods with water slightly acidulated with hydrochloric acid. (2) White cottons and linens, tartaric acid in solution; the older the stain the more concentrated the solution should be. Coloured cottons, and woollens and silks, a weak solution of tartaric acid, if the colour allows of its use. (3) Stains of red aniline may be removed by moistening the spot with strong alcohol acidulated with nitric acid. Unless the stain is produced by eosine it disappears without difficulty. Paper is hardly affected by the process; still it is always advisable to make a blank experiment first.

Fruit and Wine.—(1) White cotton or linen, fumes of burning sulphur, warm chlorine water. Coloured cottons or woollens, wash with tepid soapsuds or ammonia. Silks the same, with very gentle rubbing. (2) First rub the spot on each side with hard soap, and then lay on a thick mixture of starch and cold water. Rub this mixture of starch well into the spot, and afterwards expose it to the sun and air. If the stain has not disappeared at the end of 3 or 4 days, repeat the process. (3) Stains of wine may be quickly and easily removed from linen, by dipping the parts which are stained into boiling milk. The milk to be kept boiling until the stain disappears.

Grease and Oil.—(1) For white linen or cotton goods, use soap or weak lye. For coloured calicoes, warm soapsuds. For woollens, soapsuds or ammonia. For silks, benzine, ether, ammonia, magnesia, chalk, yolk of egg, with water. (2) Dissolve 1 oz. pearlash in 1 pint water, and to this solution add a lemon cut into thin slices. Mix well, and keep the mixture in a warm state for 2 days, then strain and bottle the clear liquid for use. A small quantity of this mixture poured on stains, occasioned by either grease, oil, or pitch, will speedily remove them. Afterwards wash in clear water. (3) Carbonate of magnesia—magnesia that has been previously calcined is best—is dried in an oven and mixed with sufficient benzine to form a soft, friable mass. In this state it is put into a wide-mouthed glass bottle, well-stoppered and kept for use. It is spread pretty thickly over the stains, and rubbed well to and fro with the tip of the finger. The small rolls of earthy matter so formed are brushed off, and more magnesia is laid on and left until the benzine has evaporated entirely. Materials that will bear washing are then cleaned with water; on silks, alcohol or benzine should be used instead. The process may be applied to textile fabrics of every description, except those containing very much wool, to which the magnesia adheres very tenaciously. It may also be used for stains, old or new, on all sorts of fancy woods, ivory, parchment, &c., without risk of injury. Ordinary writing ink is not affected by it, but letterpress quickly dissolves, owing to the absorption of the fatty matter in the ink. (4) A method of cleansing greasy woollen or cotton rags and waste. The rags are thrown into a closed revolving drum, with a quantity of perfectly dry and finely-powdered plaster-of-Paris; when the plaster has absorbed all the grease, the whole is transferred to another revolving drum, pierced with holes, by which means the greater portion of the greasy plaster is got rid of. The operation is finished by beating the rags on a kind of wooden sieve. (5) In the removal of grease from clothing, with benzol or turpentine, people generally make the mistake of wetting the cloth with the turpentine and then rubbing it with a sponge or piece of cloth. In this way the fat is dissolved, but is spread over a greater space and is not removed; the benzol or turpentine evaporates, and the fat covers a greater surface than before. The way is to place soft blotting-paper beneath and on top of the grease-spot, which is to be first thoroughly saturated with the benzol, and then well pressed. The fat is then dissolved and absorbed by the paper, and entirely removed from the clothing. (6) Castile soap in shavings, 4 oz.; carbonate of soda, 2 oz.; borax, 1 oz.; aqua ammonia, 7 oz.; alcohol, 3 oz.; sulphuric ether, 2 oz. Soft water enough to make 1 gal. Boil the soap in the water until it is dissolved, and then add the other ingredients. Although it is not apparent what good 2 oz. of ether can do in a gallon of liquid, the mixture is said to be very efficient. (7) Make a weak solution of ammonia by mixing the ordinary "liquor ammonia" of the druggist with its own volume of cold water, and rub it well into the greasy parts, rinsing the cloth in cold water from time to time until the grease is removed. The ammonia forms a soap with the fatty acids of the grease, which is soluble in water.

(8) On paper. Press powdered fullers' earth lightly upon the greasy spot, and allow it to soak out the grease. (9) Hannett says the spots may be removed by washing the part with ether, chloroform, or benzine, and placing between white blotting-paper, then passing a hot iron over. (10) A more expeditious, and thought by some, the best way, is to scrape fine pipeclay, magnesia, or French chalk on both sides of the stain, and apply a hot iron above, taking great care that it is not too hot. (11) After gently warming the paper, take out all the grease you can with blotting-paper, and a hot iron, then dip a brush into essential oil of turpentine, heated almost to ebullition, and draw it gently over both sides of the paper, which must be kept warm. Repeat the operation until all is removed, or as often as the thickness of the paper may render necessary. When all the grease is removed, to restore the paper to its former whiteness, dip another brush in ether, chloroform, or benzine, and apply over the stain, especially the edges of it. This will not affect printers' or common writing ink. (12) Lay on a coat of indiarubber solution over the spot, and leave it to dry. Afterwards remove with a piece of ordinary indiarubber. A correspondent in "Notes and Queries," Dec. 10, 1863, says, "any operation with ether, chloroform, or benzine, should never be conducted by candle-light, as their vapour is apt to kindle even at several feet from the liquid." No. (10) will remove grease from coloured calf, even if the spot be on the under side of the leather, it may thus be clearly drawn right through. (13) Apply a solution of pearlash (in the proportion of 1 oz. pearlash to 1 pint water) to oil-stained drawing-paper.

(14) Immerse the stained calico in strong soda and water, and then well wash in clean water. The soda would saponify the oil, and so render it soluble in water. If you want to carry on the cleaning process on a large scale, the best way is to boil the goods in lime-water or a solution of any alkali, and then well wash them. (15) To get grease out of woollen goods, the best way to proceed is to immerse them in a cold bath, consisting of stale urine and water, for about 20 minutes. During this time the carbonate of ammonia evolved in the decomposition of the urea combines with the grease, forming a substance which is readily removed by washing. (16) Work your linen in a lye of soda; say 1 gill commercial caustic soda to every 2 gal. water; boil, and steep in this 1 hour; wash and steep 2 hours in a solution of bleaching liquor: 1 gill bleaching liquor, at 28° Tw., to every gallon of water; wash from this, and steep 1 hour in a weak sour, say 1 gill spirits of salts to 1 gal. liquor; now wash repeatedly in water, when the stains will disappear, and the linen become clean and white.

(17) Felt hats.—Wash in a hot solution of soda or sesquicarbonate of ammonia.

(18) Floors.—Take ¼ lb. fullers' earth and ¼ lb. pearlash, and boil together in 1 qt. water, and, while hot, spread it on the greased surface, allowing it to remain 14 or 15 hours; after which it may be scoured off with sand and water. (19) Procure some good light benzoline, scrub the stained portion with a hard brush dipped in this, then wipe with a dry flannel. Make a strong solution of common washing soda in hot water, place a little unslaked lime, broken into coarse powder, over the stains, and pour on sufficient solution of soda to wet the lime thoroughly. Leave this mixture on for a short time, then scrub hard with plenty of clean hot water, and wipe dry with clean flannel.

(20) Carpet.—Upon the grease stain lay a little damp fullers' earth, and, after standing for some time, rub it gently into the carpet, and then wash off by using a little carbonate of ammonia, and the colour will be restored.

Ink and Ironmould.—(1) Equal parts of cream of tartar and citric acid, powdered fine, and mixed together. This forms the salts of lemon as sold by druggists. Directions for using.—Procure a hot dinner-plate, lay the part stained in the plate, and moisten with hot water: next rub in the above powder with the bowl of a spoon until stains disappear; then rinse in clean water, and dry. (2) Place the stained part flat in a plate or dish, and sprinkle crystals of oxalic acid upon it, adding a little water; the stains will soon disappear, when the linen should be well wrung out in two or three changes of clean water. (3) Dip the part in boiling water, and rub it with crystals of oxalic acid; then soak in a weak solution of chloride of lime—say 1 oz. to the quart of water. Under any circumstances, as soon as the stain is removed, the linen should be thoroughly rinsed in several waters. (4) The *Journal de Pharmacie d'Anvers* recommends pyrophosphate of soda for the removal of ink stains. This salt does not injure vegetable fibre, and yields colourless compounds with the ferric oxide of the ink. It is best to first apply tallow to the ink spot, then wash in a solution of pyrophosphate until both tallow and ink have disappeared. (5) Thick blotting-paper is soaked in a concentrated solution of oxalic acid and *dried. Laid immediately on a blot, it* takes it out without leaving a trace behind. (6) Muriate of tin, 2 parts; water, 4 parts. To be applied with a soft brush, after which the paper must be passed through cold water. (7) Hydrochloric acid and hot water, in the proportion of 8 of hot water to 1 of acid; if not strong enough, add more acid; when clear of stain, wash well and boil, to remove all traces of acid. (8) A weak solution of chloride of zinc.

(9) On Furniture.—Put a few drops of spirits of nitre (nitric acid) in a teaspoonful of water, touch the spot with a feather dipped in the mixture, and, on the ink disappearing, rub immediately with a rag wetted in cold water, or it will leave a white mark. It should then be polished with furniture paste. (10) Undiluted spirits of salts (hydrochloric acid) may be used in the same manner, with care.

(11) Printers' ink.—Put the stained parts of the fabric into a quantity of benzine, then use a fine, rather stiff brush, with fresh benzine. Dry and rub bright with warm water and curd soap. The benzine will not injure the fabric or dye.

(12) Marking Ink.—Dissolve 1 oz. cyanide of potassium in 4 oz. water; this mixture is very poisonous, and should, therefore, be used with great caution. Moisten the stained part of the garment with this solution by dipping it into it, or by means of a small brush; and in a few hours the stain will be obliterated. (13) To a solution of strong cyanide of potassium add a few grains of iodine. Repeated applications will remove any stain caused by nitrate of silver. (14) Grimm, in the *Polytechnisches Notizblatt*, proposes the following method for removing indelible ink and other silver stains without the use of cyanide of potassium. Chloride of copper is first applied to the tissue; it is next washed with hyposulphite of soda solution, and afterwards with water. It is said that this may be employed on coloured woven cotton tissues. For white cottons and linens, dilute solutions of permanganate of potash *and hydrochloric acid, followed* by the hyposulphite of soda and clear water, are preferable. For cleaning the hands, iodine dissolved either with iodide of potassium, or in alcohol, is used, followed by aqua ammonia.

(15) Indian ink.—To remove a blot, dip a camel-hair brush in water, and rub over the blot, letting the water remain on a few seconds; then make as dry as you can with blotting-paper, then rub carefully with indiarubber. Repeat the operation if not all removed. For lines, circles, &c., dip the ink-leg of your instruments in water, open the pen rather wider than the line, and trace over, using blotting-paper and indiarubber, as for a blot. Applicable to drawing-paper, tracing-paper, and tracing-linen. If the surface is a little rough after, polish with your nail.

Lime, lye, alkalies.—White cottons and linens, wash with cold water, Coloured goods and silks, a weak solution of citric acid applied with the tip of the finger to the spot previously moistened with water.

Mildew.—(1) Well mix together a spoonful of table salt, 2 of soft-soap, 2 of powdered starch, and the juice of a lemon. Lay this mixture on both sides of the stain with a painter's brush, and then lay the article on the grass, day and night, until the stain disappears. (2) Get a piece of flannel, dip it into whisky, and well rub the place marked; then iron on the wrong side, taking care to put a piece of damp cotton cloth between the iron and silk, and iron on the cotton cloth, which will prevent the silk assuming a shiny, glazed appearance. (3) Wash clean and take every particle of soap off, then put the linen into a galvanized bath or tub full of clean cold water, procure a little chloride of lime, and tie it up in a muslin bag or piece of muslin, dissolve the lime in lukewarm water by squeezing the bag, then pour the water among the clothes. Stir and leave them for 24 hours, but do not put too much lime, or you will rot the clothes; then well rinse in clean cold water.

Milk and Coffee.—These stains are very difficult to remove, especially from light-coloured and finely-finished goods. From woollen and mixed fabrics, they are taken out by moistening them with a mixture of 1 part glycerine, 9 water, and ½ part aqua ammonia. This mixture is applied to the goods by means of a brush, and allowed to remain for 12 hours (occasionally renewing the moistening). After this time, the stained pieces are pressed between cloth, and then rubbed with a clean rag. Drying, and, if possible, a little steaming, is generally sufficient to thoroughly remove the stains. Stains on silk garments which are dyed with delicate colours, or finely finished, are more difficult to remove. In this case 5 parts glycerine are mixed with 5 parts water, and ¼ part of ammonia added. Before using this mixture, it should be tried on some part of the garments where it cannot be noticed, in order to see if the mixture will change colour. If such is the case no ammonia should be added. If, on the contrary, no change takes place, or if, after drying, the original colour is restored, the above mixture is applied with a soft brush, allowing it to remain on the stains for 6 or 8 hours, and is then rubbed with a clean cloth. The remaining dry substance is then carefully taken off by means of a knife. The injured places are now brushed over with clean water, pressed between cloths, and dried. If the stain is not then removed, a rubbing with dried bread will easily take it off. To restore the finish, a thin solution of gum arabic, or in many cases beer is preferred, is brushed on, then dried and carefully ironed. By careful manipulation these stains will be successfully removed.

Paint, varnish, and resin.—(1) For white or coloured cotton and woollen goods, oil of turpentine or benzine, followed by soapsuds. For silk, benzine, ether, soap; hard rubbing is to be avoided. For all kinds of fabrics chloroform is best, but must be carefully used. (2) Stains of paint or varnish, after being softened with olive oil or fresh butter, may generally be removed by the same means as ordinary grease spots. (3) Saturate the spots with a solution of equal parts turpentine and spirits of ammonia; wash out with strong soapsuds.

Stearin, sperm candles:—For all kinds use 95 per cent. alcohol.

Tannin, walnut shells:—White cottons and linens, Javelle water (liquor sodæ chlorinatæ), warm chlorine water, concentrated solution of tartaric acid. Coloured goods or silks, chlorine water, diluted according to the tissue and colour, each application to be followed by washing with water.

Tar, axle grease:—White cottons and linens, soap, oil of turpentine, and water, each applied in turns. Coloured cottons and woollens, first, smear with lard, rub with soap and water, and let it stand for a short time; then wash with oil of turpentine and water, alternately. Silk the same, using benzine instead of turpentine, and dropping the water from a certain height on the under side of satin. Avoid rubbing.

Stills.—Carles recommends the use of carbonate of ammonia as an effective means of cleansing the worms of stills. The carbonate of ammonia is mixed with water in the still, and, being slowly carried over in the gaseous condition with the vapour of water during distillation, it penetrates to every part of the apparatus, attacking resins, fatty bodies, sulphuretted products, &c., and after about an hour only a perfectly inodorous limpid water flows from the worm.

Stones.—To remove grease from stone steps or passages, pour strong soda and water boiling hot over the spot, lay on it a little fullers' earth made into a thin paste with boiling water, let it remain all night, and if the grease be not removed, repeat the process. Grease may sometimes be taken out by rubbing the spot with a hard stone—not hearthstone—using sand and very hot water, with soap and soda.

Stuffed Animals.—(1) Give the animal a good brushing with a stiff clothes-brush. After this warm a quantity of new bran in a pan, taking care it does not burn, to prevent which, quickly stir it. When warm, rub it well into the fur with your hand. Repeat this a few times, then rid the fur of the bran, and give it another sharp brushing until free from dust. (2) Sponge with white soap and warm water, rubbing well into and about the roots of the hair, but avoid using an excess of water to soak into the stuffing, or the specimen will, in all probability, never thoroughly dry, and moths and rot will be the result. Dry in a current of air as free from dust as possible; brush the fur occasionally as it dries (a coarse comb at first will, perhaps, separate the hairs better). Before putting it into its case, wash freely with benzoline, rubbing with the fur; you may never dread moths, and your specimen will always be clean if your case is properly made and closed up air-tight by means of paper pasted over every joint and crack.

Teapot. — (1) Fill with boiling water and add some strong washing soda; let it remain for a day or two. (2) Weak solution of spirits of salt (hydrochloric acid).

Textile Fabrics. — The recipes under this head are mainly derived from a most useful little manual by S. Christopher on 'Cleaning and Scouring.' (Spon.)

Cleaning and scouring are, with dyers, divided into "English" and "French." The reason of these two names does not appear, as one method is as much practised by each of the two nations as the other. That known as the English method consists in scouring and washing the article to be cleaned, with a strong solution of soap, or soap and pearlash, and afterwards well rinsing it in pure water. This is the only thorough method of cleaning, and should always be adopted when the fabric is much soiled and dirty. For cleaning carpets and hearth-rugs, the English method is divided into thorough cleaning and dry cleaning. The difference between these two consists more in the manner of carrying out the several operations than in the processes themselves. In dry cleaning, when once the operation has been commenced it must be continued until the fabric—carpet or rug—is as dry as it can be got by rubbing with dry cloths; and care must also be taken that the liquor does not soak through and wet the back. In thorough cleaning, the carpet is saturated with the soap liquor. French cleaning is done with camphine, and is especially applicable for silks or satins which are not much soiled; as if used with care and despatch, it will not injure the most delicate colours.

Cleaning with Benzine. — Scouring with benzine has proved to be one of the best methods, since the end is accomplished without shrinkage or injurious effect upon the colour or finish, so that the garments need not be taken apart, nor lace or velvet trimmings be taken off, while with men's clothing it is not noticeable that they have been washed. The articles, freed from dust and dirt by beating them while dry, are thoroughly moistened with benzine in a tinned-copper or stoneware vessel, and well squeezed in it with the hands; silk pieces, ribbons, and heavier portions that may require it being brushed well on a zinc-covered table supplied with a tube beneath for re-collecting the benzine. The deepest stains are marked and treated more thoroughly. The articles are similarly treated in a second bath of benzine, and then carefully dried in a centrifugal machine for 10 to 15 minutes, the benzine being re-collected in a vessel beneath. On removal from it they are smoothed out and hung in a warm drying-room, with access of air. It will require 10 to 12 hours after they are dry to remove the odour completely. Since benzine acts principally upon fatty matter, stains of street mud, meal, &c., may remain, and must be removed by gently rubbing with a soft sponge dipped in cold water to which a little alcohol has been added, and then drying with a soft silk cloth. Sugar, champagne, and egg stains are also removed with cold water, and the colour is brought up again with a little acetic acid and alcohol in water, the spots being well rubbed out. Blood spots are treated similarly. In all these cases the formation of marginal stains around the spots must be prevented by thorough use of the soft sponge and soft silk cloth. An article that still retains decided stains is brushed with a cold decoction of soap-bark, to which some alcohol has been added, and is then rapidly passed through water, and then through water slightly acidulated with acetic acid, and dried rapidly. Kid gloves are well rubbed with the hands, separately, in benzine, and each finger then rubbed on a stretcher with a rag, and after being blown out are hung up to dry. Articles treated with benzine need but little subsequent finishing, and this may be accomplished by applying a solution of gum arabic in water, and a little alcohol, uniformly with a rag, and ironing. Portions of coats that have been taken apart need simply to be stretched and moistened uniformly with alcohol, and allowed to dry rapidly. Heavy cloth, velvets, &c., after being well steamed, are treated on the wrong side with so little dressing (best of tragacanth) that it does not go through, and are then placed on the finishing frame or warm drum. White furs and angora tassels are passed immediately from the benzine through pulverized chalk, and allowed to dry, and are then beaten out, when the leather will remain elastic and the fur look well. Benzine that has become turbid by use may be purified by stirring 10 drops of oil of vitriol thoroughly into about 2 bucketfuls of it, and allowing it to settle. The operations must, of course, not be conducted near the lamp or fire, on account of the combustibility of benzine.

Definitions, &c.—Board required for cleaning with Camphine.—The scouring board for French cleaning ought to be 6 ft. long and 3 ft. wide, and should be made of 1-in. American pine, free from splits and knots, and planed very smooth and level. One side of this board is covered with green or drab baize, stretched very tight and smooth, and fastened to the edges by tinned-tacks. Besides this board will be required 3 silk-scouring brushes, of different degrees of hardness—these should be bought of a dyers' brush-maker; a large sponge, some clean pieces of flannel, and some clean India-cotton cloths and sheets.

Camphine is a variety of spirits of turpentine, and is obtained from the *Pinus australis* of the Southern States of America. It is sold in sealed tin boxes or cans, containing 1 qt., 2 qt., or 1 gal. each, and can be obtained at almost any oil shop or drysalter's. When it is too dirty for further use, it is taken back to the shop at which it was purchased and exchanged for clean; one pint of clean camphine being given for each quart of that which is dirty.

Common Sour is prepared by stirring into clean water sufficient oil of vitriol to make it taste sharp. The vitriol is to be bought at a drysalter's, not at a chemist's.

Drying.—Dresses, and all coloured fabrics, should always be dried in the shade, and never in the sunshine; for the best colours are sure to fade if they are exposed to the glare of the sun, and more especially will they do so when wet.

Frame for finishing Silks, &c.—This consists of a frame, made generally of oak and iron, on which the silks are stretched before sizing; and is so constructed that a pan containing burning charcoal may be run backwards and forwards under the silk to dry it.

French Board, for finishing Silks, &c.—Have a deal board, about 4 ft. 6 in. long, 2 ft. wide, and 1 in. thick. Cover this board loosely with fine green or drab baize, well tacked to the edges of the board, and then stuff it with wool from both sides, until it is very tight and smooth. When stuffed, it should be slightly raised along the centre of its length and slope off towards each side. To use this board, take a width of the silk or satin which has been cleaned, lay it flat and smooth on the baize, and then sponge it carefully all over with a mixture of size and water. When this has been done, pin down first one end and then the other, and also the two sides. The silk is to be well stretched while being pinned, and the pins are to be put in about 1 in. apart. Rub the face of the silk once more with a damp sponge, and then dry it before a clear fire. When dry, unpin and take it off the board, and it is finished.

Hot Stove.—A hot-stove room is the best place in which to dry work which has been cleaned with camphine; and the hotter the room is the sooner will the smell of the camphine be expelled from the fabrics.

Irons.—The best kind of iron to use for ironing dresses, ribbons, &c., is a box iron, on account of its cleanliness.

Parchment Size, for finishing Silks, Bonnets, &c.—Well wash 1 lb. of parchment shavings or cuttings, in two or more lots of cold water; then put them into a saucepan, or other vessel, with 4 qt. of cold water, and let them simmer gently until the quantity is reduced to 2 qt. Strain through a fine sieve, and it is fit for use. One teacupful of this is sufficient to stiffen one bonnet, or to mix with 1 qt. of water for finishing silks.

Pegs are pieces of wood, firmly fastened into the walls of the dye-house, at a height of 6 ft. from the floor, and projecting from the wall about 18 in., and are placed at intervals of about 2 ft. Articles which have been cleaned or dyed are put on these pegs to drain. When cleaning curtains, dresses, or other similar articles, the kettle or tub is always stood under one of these pegs. For domestic use, a plain deal horse, made like a towel-horse, may be substituted for these pegs.

Puncher.—This instrument is used for beating or punching those articles which are too heavy to be taken in the hands and rubbed. It consists of a rather heavy mallet-like block of hard wood, fixed to a long tapering handle.

Size for Coloured Bonnets.—Break up 1 lb. of the best glue, put it into a vessel with 4 qt. of cold water, and let it soak for not less than 12 hours. Then pour it, water and all, into a saucepan, and put it over the fire to dissolve. Keep it well stirred, and be careful not to let it boil. When it is all well melted, strain it into an earthenware pan, and use it while it is scalding hot. The bonnets as they are taken out of this size must be sponged as dry as possible, and the shape regulated, and then hung up to dry. This quantity is sufficient for 12 bonnets.

Soap.—The best kind of soap to use is Feild's oil soap. This kind has no unpleasant smell, and does not congeal after being dissolved. Mottled soap is the next best kind, but it requires to be used while warm to get it well into the work. The great drawback to its use is, that after being dissolved, if it is allowed to cool it congeals, and therefore it is not suitable for cold scouring and cleaning. Soft-soap, which is made from fish oil, is not fit for general use, on account of the fishy smell remaining in the work.

Starch.—Mix a quartern of the best flour with cold water, and when it is well mixed pour on it two pails of scalding water, and put into it 2 oz. of beeswax. Now set it to swim in a copper of boiling water for ½ hour, and stir it occasionally. Take it out of the copper and strain it into a clean vessel, and when cool it is ready for use. This is for starching articles which are to be friction-calendered or glazed. The best starch for dresses, and for all domestic uses, is the Glenfield starch.

To Handle is to pass the work from one hand to the other, by the selvage, keeping it under the liquor all the time.

To Sheet-up.—To rub dry with sheets.

Water.—All water used for cleaning or scouring, whether hot or cold, should be quite pure and clean.

Ancient Tapestry.—Dissolve a bar of soap in 1 gal. boiling water; when cold put 1 qt. of this dissolved soap into 1 gal. cold water. Have ready at hand some pieces of soft flannel, a soft brush, a piece of washleather, and some clean, dry sheets. First well brush with a hard, long-haired clothes-brush, taking care to remove all the dust from the corners; for this latter purpose it is better to use a small pointed brush and a pair of bellows. If the tapestry is on the wall, begin to clean it at the top, but do not clean more than 1 sq. yd. at a time. Dip a piece of flannel into the soap liquor, squeeze it out gently, and well rub it into the tapestry to make it lather, and well brush with a soft brush. Then wring the flannel out of the soap liquor, and dry the square with the soapy flannel and the washleather, and afterwards dry with the sheets. The tapestry is to be dried with the soap in it, for on no account must it be rinsed. Dissolve 4 oz. tartaric acid in a pint of boiling water, and put it into a pan containing 2 gal. cold water. Dip a clean sponge into this acid water, squeeze it, and then well rub it into the spot you have just cleaned and dried. When this has been done, it must be again well dried with the sheets before being left. And so proceed, 1 sq. yd. at a time, until the whole is cleaned. The soap liquor must be thrown away, and a fresh lot mixed, as often as it becomes dirty. When the tapestry has all been cleaned, and it is quite dry, take a lump of pipeclay and well rub it into it, and then brush it with a clean clothes-brush. This last process takes out the soap and spirits, and also brightens the colours. Keep a good fire in the room while you are cleaning the tapestry.

Carpets.—All carpets and hearth-rugs, whether intended for dry or thorough cleaning, must first be well beaten, and swept or brushed with a hard broom. A carpet, to be properly beaten, should be hung on a stout line, the wrong side outwards, and well beaten by two or more persons, according to its size, some standing on one side and some on the other. The sticks used should be pliable, and well covered at the ends with cloth in the form of a knot in order to prevent the carpet being torn or the seams split by the sharp ends of the sticks. After being thoroughly beaten on the wrong side, the carpet should be turned and treated in the same manner on the right side.

Dry Cleaning.—Have ready a number of dry coarse cotton or linen cloths, some coarse flannels, and one or more large pieces of coarse sponge; two or more hard scrubbing or scouring brushes, some large tubs or pans, and pails, and also a plentiful supply of both hot and cold water.

First take out all grease spots; this may be effected in several ways. Well rub the spot with a piece of hard soap, and wash out with a brush and cold water, and well dry each spot before leaving it.

Or use, instead of the soap, a mixture of fullers' earth, gall, and water, well rinsing and drying each spot as before.

When this has been done, the carpet may be cleaned by one of the three following methods:—

(1) To Dry Clean with Soap Liquor.—Cut up a bar of soap and dissolve it over a fire in 2 gal. water. Put 2 qt. of this dissolved soap into a pail of warm water. Dip a scrubbing brush into this *soap liquor*, and scour with it about 1 sq. yd. of the carpet; be careful not to let the liquor soak through to the back. When this piece is thoroughly cleaned, rub the soap well out of it by means of a coarse flannel or sponge, sucking up all the wet and dirt made by the brush; rinse the flannel or sponge frequently in warm water. Now take a clean sponge and dip it into a pail of common sour, squeeze it out, and then rub the sour well into the part just cleaned and rinsed. Rub as dry as possible with clean, coarse cotton or linen cloths before proceeding with the cleaning. The whole carpet is to be cleaned, spirited, and dried in the same manner, a square yard at a time.

(2) To Clean with Gall.—Put a bag of very fresh bullocks' gall into a pail containing 2 gal. cold water, with 4 oz. pearlash dissolved in it, and well mix it either with a stick or your hands. Have ready, besides this, 2 pails cold water, a large sponge, a couple of flannels, and some dry, coarse cloths. Dip the brush into the gall and water, and scrub the carpet, a square yard at a time, as quickly and as carefully as possible. Rinse, and suck up the gall and dirt with a large flannel or sponge, which is to be frequently rinsed in the pails of cold water. Well dry with cloths before beginning a second square.

By adopting this simple process, any carpet, whatever its size, may easily be cleaned on the floor; the process is especially useful when the carpet is not very dirty, or when it contains delicate colours, as the gall cannot possibly injure them. The only objection to this method is that when cleaned with gall there is often a disagreeable smell left in the carpet; but if the gall be obtained from a fresh killed bullock, and the carpet, after cleaning, be hung for a few hours in a current of fresh air, the whole of this smell will go off.

(3) To Clean with Ammonia.—Dissolve in a small pan 4 oz. pearlash in hot water, and mix with it 1 gal. ammonia, which must be obtained from a drysalter, not from a chemist. Dip a sponge or coarse flannel into the ammonia, take it out rather wet, and well rub it into the carpet, then dip the scouring brush into the liquor and well scour the part already sponged as quickly as possible. The dirt and ammonia must then be sucked up in the sponge or flannel, and the part well dried with flannels and cloths before proceeding with the next. Each square yard will take about 20 minutes to clean and dry thoroughly.

This is another very simple method, the only objection to it being that the carpet will smell of the ammonia for some time if it is kept in the room in which it has been cleaned; it should therefore be hung for 3 or 4 days in the open air or under an open shed, taking care, however, that it does not get wet.

In dry cleaning, special care must be taken not to allow the liquor to soak to the back of the carpet or rug; and also that, before commencing, the floor or board on which the operation is conducted, is perfectly dry. A good fire should also be kept in the room during the whole time, as much of the success of the operation depends on rapid drying.

Thorough cleaning. (*a*) Lay the carpet on a stone floor, having a fall of about 6 in., so that the soap and water may drain off as used, and well scour with a long-handled scouring brush, using the dissolved soap liquor in the manner described in the *first* process for dry cleaning. When well scoured all over, scour out the soap and dirt with plenty of cold water, fold and lift on to pegs to drain. While the carpet is draining, sweep and well rinse the flags; and then lay down the carpet, and well rinse and scour it a second time with plenty of cold water. Refold and hang on the pegs to drain, and again well rinse and sweep the flags. This must be repeated until all the soap and dirt have been got out of the carpet; it must then be hung on the pegs, and the floor once more swept and rinsed. Have a tub or other vessel containing 12 pails cold water, and stir into it ½ pint oil of vitriol; spread the carpet evenly on the floor, and, with a pail, pour this sour carefully all over the carpet, and well work it in with a carpet broom. This, which is a very important process in carpet cleaning, must be performed with care and attention to the colours, especially when there are greens and blues. When done, fold up the carpet very smoothly and put it on the pegs to drain, and afterwards dry as quickly as possible, either in a hot room or, on a dry day, in the open air.

(*b*) Have a board 3 ft. wide and 12 ft. long, so that two persons can work at it at the same time. Place this board on trestles, or horses, 3 ft. high, and on the ground underneath it place other boards, on which to drop the carpet as the scouring progresses. Place the carpet smoothly on the scouring board, face upwards, and well scour with hand-scouring brushes, using the soap liquor as before. When this length has been scoured, pull the carpet towards you and let it drop smoothly on to the boards at your feet, and then scour the second width in the same manner; and so proceed until the whole carpet has been scoured. Then fold it up and put it on the pegs to drain, and clean away all the soap and dirt from the boards and floor. Place the carpet on the scouring board as at first, and well scour out the soap and dirt with plenty of cold water; fold up the carpet and put it on the pegs to drain, and again rinse the boards and floor; and so continue until all the dirt and soap have been got out of the carpet. Then well clean the scouring board, the boards at your feet, and all places about them. Put the carpet once more on the scouring board and finish with the sour as directed for the first method, well scouring it in breadth by breadth. Drain and dry as before. Carpets cleaned in this manner will look and wear as well as when they were new.

(*c*) First take out all the grease spots with a mixture of fullers' earth and gall. Dissolve 1 lb. pearlash in boiling water, put it into a tub with 6 pails of cold water, and then well mix into it 2 large gall bags, which should be very fresh; this will be sufficient to clean a carpet containing about 30 sq. yd. Spread the carpet either on the flags or on the scouring board, and use this preparation in exactly the same manner as you would the dissolved soap liquor; scouring, rinsing, spiriting, and drying the carpet just the same.

Never attempt to clean the back of any carpet, as the backs are sure to get clean with cleaning the face.

Cloth.—Cloth trimmings often become soiled, and unless cleaned, the appearance is impaired. Benzine and naphtha are used with success for this purpose upon grease spots, but when there is no grease, the materials fail, and are likely to produce bad results, owing to the oil that is contained in them. To remove the oil place a quantity of benzine in a bottle and drop into it a little oxalic acid; this will carry with it to the bottom of the glass all the oil remaining in the benzine, leaving the greater part perfectly pure. After standing for an hour or two, carefully pour off the clear fluid on the top into another bottle, and it will be ready for use.

Curtains, Bed Furniture, &c.—Chintz.—Printed or chintz curtains do not require to be unpicked or unlined for cleaning and glazing; but if they are to be friction-calendered, they must be unlined and taken apart in breadths. Lined furnitures, as sofa, chair, or ottoman covers, and hangings which have not been unpicked, must have a strong and good starch, which will require to be well worked into them. Unlined furnitures and linings, which are to be friction-calendered, will only require to be carefully passed through a thin starch; if, however, they are to be glazed, they will require the strong starch the same as the lined furniture. If dried before being starched, all kinds of furniture will take one-fourth less starch, and will also be much stiffer than if starched while wet. Furniture which is to be friction-calendered must, after starching, be wrung across the width, and the ends and edges well shaken out and pulled straight; and they should afterwards be hung up very straight by the ends.

To clean the furniture: Dissolve a bar of soap in 4 gal. boiling water. Put 1½ gal. of this soap liquor into a vessel containing 4 pails of cold water. This is called the first liquor. Into another vessel put the same proportions of cold water and dissolved soap, for the second liquor; and put the remaining gallon of soap liquor into a third vessel containing 4 pails of cold water. This is the *thin soap liquor.* Put your furniture into the first soap liquor, and well rub and punch it; wring it out and put it into the second liquor, and well rub, punch, and turn it in this; then wring it out again and pass it into the third or thin liquor to finish, and give it a clean water directly after. Now well rinse it through 3 lots of moderately warm water to take out all the soap; and afterwards starch by well working the starch all through it. When this has been done, well shake it and fold it neatly; when dry, send it to the calico glazers to be finished.

When the furniture is to be friction-calendered, first well punch the print in a tub of clean water, and, while the print is draining, well punch the lining in the same water, and repeat this with a second tub of water. The furniture is then to be cleaned, rinsed, and starched, as above directed; excepting that the print is to be passed first through each soap liquor and rinsing water, and through the starch, and the lining is to follow in the same order.

Damasks.—Dissolve 6 lb. soap in 8 gal. boiling water; and in another vessel dissolve 3 lb. best pearlash in 2 gal. boiling water. First clean the curtains, one at a time, in two lots of clean water, well working them in each water; then fold them up smoothly, and put each curtain on a peg by itself to drain. Put 6 pails warm water into a tub, and into this put 2 qt. of the pearlash liquor and 2 gal. of the soap liquor. Put one of the curtains into this liquor, and well work it with the puncher for 10 minutes, then fold it up and put it on a peg to drain, and treat the other curtain exactly in the same manner. Now throw this liquor away, and make up a second lot with the same proportions as the first. Pass the curtains through this in the same manner as before, letting the one which was second be first this time. Put this liquor into another vessel and make up a third lot, and well work the curtains in this as before. Empty this liquor into the vessel containing the last, and mix another lot. Punch the curtains in this as before, one at a time, for 10 minutes, fold up and put on the pegs to drain, and they are ready for spiriting. Rinse your tub and put into it 12 pails of cold water, and into this stir ½ pint of oil of vitriol. Open your first curtain and well handle it in this spirit water for 10 minutes, then fold and hang up to drain. Stir another ¼ pint of oil of vitriol into this same water, and treat the second curtain in the same manner as the first. Now throw this spirit water away, well rinse the tub, and fill it with cold water. Rinse the first curtain in this, then throw away the water, refill the tub, and rinse the second curtain. Fold them up smoothly, drain them, and they are ready for drying. To dry these curtains properly they must be hung up in a warm room by the ends, the middle hanging down. This is of great importance and must be attended to, for if they are not dried straight they cannot be re-made straight, and consequently will not hang again like new. After drying they are to be well shaken and picked out, and then sent to the pressers to be finished.

The proportions and quantities here

given are for a pair of curtains, each containing 20 sq. yd.

Worsted-and-Cotton Damasks are to be cleaned exactly in the manner described above, excepting that after being spirited and rinsed, and before being pressed, they must have a water starch to make them look strong and well when finished.

Silk Damasks.—Dissolve 2 lb. Feild's soft-soap in 2 gal. boiling water, and while it is getting cold get ready your silk-scouring brushes and scouring board. Have 3 vessels, each containing 6 pails of cold water for rinsing, and a fourth, containing the same quantity of water, into which sufficient oil of vitriol has been stirred to make it taste sour; also a kettle, containing 4 pails of water for a soap liquor. Put 1 qt. of the soft-soap liquor into a pail of cold water, dip one width of the damask into this, then put it on the scouring board, the wrong side up, pour some of the dissolved soap on it, and well brush with the silk-scouring brush. This must not occupy more than 5 minutes. Turn it and clean the right side quickly with the brush and more of the soft-soap. Now take it off the board and pass it through the first soap liquor, then through the thin liquor, the rinsing waters, and the spirit water; well handling it in the spirits for 2 minutes. Wring it, fold it up, and dry; and so proceed for each width, the quantities here given being sufficient to clean about 10 sq. yd. After drying, they must be damped, brushed, and framed, and sent to the pressers to be finished.

Silk damasks may also be cleaned with camphine, in the following manner: Well shake and brush the curtains, and take the widths apart. Have ready the camphine board, brushes, and sheets. Put 1 gal. camphine into an earthenware pan that will hold 4 gal. Put in a width of the damask, and handle it in the camphine until it is well soaked, which will be in about 2 minutes; then fold it up and lay it on a peg over the pan, so as to catch the liquor which drains from it. Now put it on the scouring board, wrong side up, and brush it well; then turn up the right side, and do the same with it. Pass it again through the camphine, fold it up, squeeze out of it as much of the camphine as possible, and lay it on the peg over the pan. Now turn your board the wood side upwards, and put your sheets on it. Then sheet-up the width which you have just cleaned, using one sheet after the other until it is quite dry; then brush it well on both sides, and hang it up to air and take off the smell of the camphine. Each width of the curtain or furniture is to be treated in exactly the same manner as above. When dry they are ready for dressing.

Mix 1 teacupful of parchment size with 4 qt. cold water. Frame the damask, and carefully wet all over with this by means of a clean sponge, and dry immediately with the charcoal fire. Afterwards send them to the pressers to be finished. Some dyers and cleaners prefer damping, brushing, and calendering as a finish for this work; while others frame or roll it only. But this will all depend on the quality of the work and the dressing.

Rapidity of operation is of great importance in this method, for if the operator be a dawdler the work is sure to suffer. Each width, from the time it is put into the camphine until it is hung up to air, should not on any account take more than 15 minutes.

Silk-and-Worsted, or French Damasks.—To clean a curtain, or other furniture containing about 10 sq. yd. Dissolve 3 lb. soap in 8 gal. boiling water; have ready 3 tubs, each containing 6 pails cold water, and into the first and second put 1 pail of the dissolved soap, and ½ pail into the third. Put into a large kettle, or other vessel, 6 pails cold water, and well stir into it ¼ teacup of oil of vitriol.

Put the curtain into the first soap liquor, and well work it for 1 minute, then take it up by the selvage and wring it over the tub; put it back into the same liquor and again well work it for a minute, and then well wring it on a peg over the tub. Now treat it in the same manner in the second liquor, then put it into the third or thin soap liquor, and when it has been well worked in this, handle it directly out of the soap into the spiriting, wring it out on a peg, put it back into the spirits, and again well handle it for about a minute, and then put it to drain. Throw away the first soap liquor, rinse the tub, and put into it 10 pails of cold water and ½ teacup of oil of vitriol. Well handle the curtain in this, wring it out, return it twice to the same liquor, and then hang it on to the pegs to drain. Empty your tub and make up a second spirit water, with ¼ teacup of oil of vitriol in 12 pails of water, well work the curtain in this, and afterwards put it to drain. After it has drained well, dry it with clean sheets, and then hang it in a warm room to finish drying. When dry, damp, brush, and send to the pressers to be finished. The sheeting-up should be carefully performed, and must on no account be omitted, as the whole safety of the colours depends on this operation. Each curtain is to be cleaned in the same manner, and will take about 6 sheets to properly dry it; but with each fresh curtain the second soap liquor is to be used as the first, and a fresh lot mixed for the second liquor.

Moreens are to be cleaned, rinsed, and spirited, exactly as first described for damasks. When sent to the pressers, moreens may be finished in one of the four following ways, plain, watered, embossed, or with satin and watered stripes, the charge per yard being about the same for each method.

Tabaret or Tabbarea.—This may be cleaned and finished in the same manner as described for silk damasks, excepting that when it is sent to the pressers it is to be watered instead of hot-pressed.

To clean with camphine: Have your board, brushes, and drying clothes all ready, and put ½ gal. camphine into each of 2 earthenware pans that will hold about 2 gal. each. Well shake and brush the curtains, take out the linings, and take them apart. Put one width into one of the pans of camphine; when it is quite soaked, take it out and lay it on your board, wrong side up, and well brush it with the camphine; turn it and treat the right side in the same manner. Now pass it again through the first liquor, and then through the second, letting it drain on a peg over the latter for a minute. When it has drained sufficiently, sheet it up dry with the cotton or linen cloths, then brush it with a dry brush, and hang it up to air and take off the smell of the camphine. Each width is to be cleaned in the same manner, using fresh camphine as often as necessary. When all have been dried, put them for a few minutes between some damp sheets, then take them out, brush and rub them, and send to the pressers to be watered.

Satin.—Have 2 clean stoneware pans that will hold about 2 gal. each, and into each pan put 2 qt. of camphine. Shake and well brush the curtains and take them apart. Put one width of the satin into one of the pans of camphine, let it well soak through, and then drain it on a peg over the pan for about a minute. Now put it on the board, the wrong side up, and well brush it with a soft brush, occasionally wetting the brush in the camphine. When the wrong side has been cleaned all over, turn the right side up, and clean it with the brush in the same manner; and afterwards pass it through the first liquor, and then through the second, and well drain it. Now turn your board the plain side up, lay the width on it, and well dry with the cloths. After it is dry, brush it, first on the wrong side and then on the right side, with a dry brush, and then hang it up to air and take off the smell of the camphine. Each width is to be cleaned in the same manner, using clean camphine as often as required. Satins are generally finished in the frame in the manner described for silk damasks, and afterwards sent to the calender. Another very simple way is to slightly damp them between clean sheets, then brush them and send to the pressers to be finished.

Satins may also be cleaned, dried, damped, brushed, framed, and finished, exactly as described for silk damasks.

Tammy Lining.—(1) Dissolve 1 bar of soap in 4 gal. boiling water; have 3 vessels, each containing 2 gal. cold water. Into the first of these put 2 gal., into the second 1½ gal., and into the third 1 gal. of the dissolved soap. Tack the widths of lining together, end to end, and then put it into the first soap liquor, work it well in this, then put it into the second liquor, and again well work it. Now put it into the third liquor, handle it well in this, and afterwards put it on a clean peg to drain. Put 8 gal. cold water into a clean vessel, and stir into it one tablespoonful of oil of vitriol; handle the lining in this spirit water for 5 minutes, take it out and rinse it in one lot of cold water for about a minute. Now dry it, and when dry have it re-glazed on the wrong side. (2) Mix together the crumb of a stale loaf and a quart of silver sand, and damp the mixture with camphine. Put a dry width of the tammy on the scouring board, and well work this mixture into it, on both sides. Then shake it and brush it, and it is cleaned. Again damp the mixture of bread and sand with a little fresh camphine, and clean the next width in the same manner. And so proceed for any number of widths. (3) Tammy lining may also be cleaned with camphine, in the manner directed for tabaret; but a flannel should be used to rub out the dirt instead of a brush.

When cleaned by either of these last two methods the tammy will not often require re-glazing, unless it was very dirty before cleaning. But whenever it is necessary to re-glaze it, it should be done on the wrong side.

Bullion Fringe and Worsted Fringe should be cleaned in the soap liquors, spirited, rinsed, and dried, exactly as directed for tammy lining. But if the fringe contains any spickets, that is, pieces of wood covered with silk, these must be taken off and cleaned with bread-crumbs and camphine, or, if necessary, sent to the fringe makers to be re-covered.

Bullion Lace and Gimp are to be cleaned in camphine and dried in cloths, piece by piece, in the manner directed for tabarets.

Silk curtains, when soiled, may be made to look as good as new by washing them in a liquid composed of ½ pint gin, 4 oz. soft-soap, 2 oz. strained honey, well mixed; spread the silk out on a table and apply the mixture with a sponge, rubbing thoroughly; then wash in soft water, into which there should be put 2 tablespoonfuls of ox-gall to 3 gal. of water, rinse the silk, but do not wring it; hang it out smooth to dry, and iron when damp.

Dresses.—Silk.—Have two earthenware vessels that will hold about 2 gal. each, and put ½ gal. of camphine into each of them. Take the sleeves off the dress, and the body off the skirt. Clean the body first, next the sleeves, and the skirt last. Put the body to soak in the first liquor, and when it is well wetted lay it on the board, and well brush it with the silk scouring brushes, first on the inside and afterwards on the outside. When this has been done, put it back into the first liquor, and then into the second, and let it drain on a peg over the latter for about a minute. Have a clean sheet spread out on the plain side of the board, take the body off the peg, and lay it smoothly on this and well rub it, with clean India-cotton cloths, until quite dry. The sleeve and the skirt are to be cleaned and dried in exactly the same manner. Hang in a hot room to take off the smell of the camphine.

This is a very quick and easy way to clean a silk dress. But if it should be very dirty it will be found to be much better to take it apart into widths, and to clean each width separately by either of the two following methods;—(1) Dissolve 2 lb. of soap in 2 gal. of boiling water, and use when cold. Have 4 pans, or other vessels, with 4 pails of cold water in each. Into one of these put a small quantity of the dissolved soap for a thin soap liquor, and in another dissolve ½ lb. of tartaric acid for spiriting. The other two lots of water are for rinsing. Now begin and clean the dress as quickly as possible, for each width should not take more than 5 minutes from first to last, or it will probably be spoiled. Spread the width, wrong side upwards, on a clean scouring board which is rather longer and wider than a width of the dress. Pour over it sufficient of the dissolved soap to wet it thoroughly, and well brush it, lengthwise, with a soft brush; then turn it and treat the right side in the same way. When this has been done, pass it first through the thin soap liquor, then through the two rinsing waters, and afterwards well handle it in the spirit water, and then put it on a peg to drain. Now spread a clean, dry sheet on a dry board or table, lay on it the width which you have just cleaned, and well dry it with clean cloths, and afterwards brush it with a dry brush. When all the widths have been cleaned and dried they should be finished either in a silk-finishing frame or on a French board. Silks or satins should never be brushed across the widths, as doing so causes them to fray out, and spoils them for re-making.

(2) Have 2 clean earthenware pans, which will hold about 2 gal. each, and put ½ gal. of camphine into each. Take one breadth of the dress and dip it into the first lot of camphine, then spread it on the board, dip the brush into the camphine, and brush the width as above directed. When this has been done, put it again into the first liquor, then into the second, and let it drain for a minute over the latter. Be sure to squeeze out as much of the camphine as possible before passing the width from one liquor to the other. Spread a clean sheet on the board, lay the breadth of silk on it, and dry thoroughly. And so proceed for any number of widths. Hang in a hot room to take off the smell of the camphine. Finish either in the frame or on the French board.

Satins may be cleaned by either of the methods given for cleaning silks.

Irish Poplins and Tabinets are to be cleaned with camphine, in the manner directed for Tabaret curtains.

Lama.—Boil 1 lb. of the best rice in 1 gal. water for 3 hours, and when done pour off into a basin a sufficient quantity to starch the dress. When the remainder is partially cold, well wash the dress with it, without using any soap, and rinse in cold water. Wring it well, and starch it with the rice water put by for the purpose, and dry quickly before the fire. When sufficiently dry, it is ironed with a cool iron, as it is very liable to scorch; use a wet cloth to damp the parts which may have become too dry for ironing. These dresses must on no account be allowed to lie damp, even for an hour, or they will be spoiled, as the colours are sure to run.

Alpacas, Printed Muslins, or Piqués may also be cleaned by this method, for if the operation be performed with care and despatch, it will be found not to injure the most delicate colours.

Piqués and Coloured Muslins.—French method: Make a strong lather with best white soap dissolved in soft water, and use while rather warm, but not hot. Wash the dress in this, but do not soak it previously. As soon as the lather appears soiled, squeeze out the dress, throw away the lather, and wash the dress again in a second lot, and so continue until the dress is thoroughly clean. Then well rinse it in cold water, and afterwards in cold water slightly blued. Squeeze all the water out of the dress, but do not wring it, and hang in a shady place to dry; or, if the weather be wet, dry it before the fire. When dry, they are to be starched. It is in this operation that the failures in getting up muslins and piqués more often occur than in the washing. Use a large basin and have plenty of starch, and dissolve in the starch, according to the quantity of it, 3 or 4 in. of composite or wax candle. Squeeze the starch well out of the dress, and while it is still wet put it between some old sheets or tablecloths, and pass it between the rollers of a wringing machine or under a mangle;

by this means all lumps of starch will be removed. Finish by ironing. Piqués should be ironed on the wrong side, as lightly as possible.

Flannel.—(1) To prevent shrinking in washing, soak the flannel for a night in cold water when dirty, and the next morning wash with curd soap in very lukewarm water. Don't wring, but press the water out and hang to dry. (2) Cleaning white flannel. Use pipeclay, which should be mixed to proper consistency in a pipkin; stand on the fire till warm, stir with wax candle for 5 minutes, add a modicum of soap and a dash of Prussian blue, and stand by to cool, and always use cold, laid on with a sponge, and dry in shady breeze. For grease spots, lay over them pure clay, size the thickness of a crown piece, then place in the sun, and the clay will absorb all the grease without fail. When trousers are dry, rub them to loosen the clay, which brush off, and you will have cleaner looking trousers than by washing, and they will be fit to wear two or three times without pipeclaying. The same for flannel jackets.

Hearth-rugs. — Hearth-rugs should never be cleaned on the floor, but on a large scouring board, and should only be operated upon $\frac{1}{6}$ of their length at a time. After being cleaned, they require to be dried very quickly; as otherwise, on account of the thickness of the pile, they are apt to sadden.

Hearth-rugs may be cleaned by either the first or second methods given for dry-cleaning carpets; with the following exception, that when the first method is adopted, only 1 lb. of soap dissolved in 1 gal. of hot water will be required. After the rug is finished, dip a clean sponge into a pail containing a little common sour, and well rub it into the face of the rug.

Lace.—Cover an ordinary wine bottle with fine flannel, stitching it firmly round the bottle. Tack one end of the lace to the flannel, then roll it very smoothly round the bottle, and tack down the other end, then cover with a piece of very fine flannel or muslin. Now rub it gently with a strong soap liquor, and, if the lace is very much discoloured or dirty, fill the bottle with hot water, and place it in a kettle or saucepan of suds and boil it for a few minutes, then place the bottle under a tap of running water to rinse out the soap. Make some strong starch, and melt in it a piece of white wax and a little loaf-sugar. Plunge the bottle 2 or 3 times into this and squeeze out the superfluous starch with the hands; then dip the bottle in cold water, remove the outer covering from the lace, fill the bottle with hot water, and stand it in the sun to dry the lace. When nearly dry take it very carefully off the bottle, and pick it out with the fingers. Then lay it in a cool place to dry thoroughly.

Shawls and Scarves.—China Crape, Brocaded or Printed Silk.—They may be cleaned by either of the methods, and in the same manner, as directed for silk dresses.

Woollen.—Scotch method: Scrape or cut up 1 lb. of soap, and boil it in a small quantity of water. When sufficiently cool, beat it to a jelly with the hand, at the same time mixing with it 3 tablespoonfuls of spirits of turpentine, and 1 of spirits of hartshorn. Wash the shawl thoroughly in this, then well rinse in cold water, and, when all the soap is out, in salt and water. This last need only be done when the shawl contains delicate colours. Then fold the shawl between two sheets, being careful not to let two folds of the shawl come together. Mangle, and afterwards iron with a very cool iron.

Sheepskin Rugs and Mats.—Dissolve 1 bar soap in 2 gal. boiling water. Put 2 qt. of this into a tub or pan containing about 2 gal. warm water. First rub out the dirt and grease spots with the strong soap liquor, or, if necessary, with fullers' earth. Then put the rug or mat into the tub containing the weak soap liquor, and well wash and punch it. Throw away this first liquor, and mix another lot with the same proportions of warm water and dissolved soap, and again well wash the rug; and so continue until it is perfectly clean. Then rinse well in cold water to take out all the soap, and afterwards in cold water in which a small quantity of blue has been dissolved. This blue water will only be required for white skins. After this has been done, the mat or rug should be wrung out, shaken, and hung to dry with the skin side towards the sun, but not when the heat is scorching, or the skin will become hard and brittle. It should, while drying, be frequently shaken and hung up first by one end and then by the other.

Silk Handkerchiefs, Ribbons, Mantles, and Fancy Waistcoats.—Have 2 large earthenware pans, and put 2 qt. of camphine into each pan. Dip the article, whatever it may be, into the first liquor of camphine, well handle it in this, and repeat the operation in the second liquor. Then drain; have a dry sheet on your board, lay the article on it, and dry well with fine cloths. Finish by ironing with a box iron.

Table Covers.—Dissolve 1 bar of soap in 4 gal. boiling water, and mix with it 1 lb. pearlash. Have 3 earthenware pans or tubs that will hold about 8 gal. each; into the first of these put 3 gal. of the dissolved soap and 1 pail cold water; into the second, 2 gal. soap and 1 pail water; and into the third, 2 pails water and 1 gal. dissolved soap. Well work the cover in each of these 3 soap liquors, beginning with the strongest, and wring it between each. Stir 1 tablespoonful of oil of vitriol into a tub containing 6 pails cold water. Handle the cover in this spirit water for 5 minutes, then take it out and rinse it in one lot of cold water; this is the proper method for cotton-and-worsted or printed cloth covers. Table covers made with a mixture of silk and worsted, instead of being spirited after cleaning, should be well worked in a pan containing 2 pails cold water, in which 1 lb. common salt has been dissolved, and afterwards rinsed through 2 lots of cold water. Dry quickly; then shake, brush, and finish by ironing with a box iron, or send to the pressers to be finished.

Tobacco Pipes.—A very simple and effective plan. Cut ½ in. from the end of an ordinary cork, and fit it tightly into the bowl of the pipe. Then with a knife cut a hole through the cork wide enough to admit the nozzle of a water tap with a little pressure, turn on the water gently until the flow through the stem is sufficiently strong, and let it run until the pipe is clean.

Vellum.—Benzine applied with a sponge. It will remove almost every stain, and does not destroy the texture in the least.

Violin.—(1) Use soap and water, but avoid its running through the "*f*" holes. Clean the interior with *dry* rice. Do not use spirit. (2) Moisten the solid parts with salad oil, then mix same oil and spirits of wine together in a basin, trying its strength first on a part of the neck or scroll, then with a piece of white linen rag, dipped in the oil and spirit, rub the soiled parts, keep shifting the rag as it gets dirty: it will take several days to do, but keep the parts well soaked, where dirty, with oil after every rubbing; but by no means scrape it. (3) Ordinary paraffin oil. *Slightly* saturate a rag of soft silk, and proceed to wash your violin therewith. The effect is almost magical; the paraffin dissolves the crust of dirt and resin and cleans the varnish without injuring. (4) For the outside, a strongish solution of washing-soda, applied with piece of flannel. If you find the soda remove the varnish (as it does with some oil-varnishes), use soap-and-water, and then paraffin. When clean, rub with linseed-oil; spirits of wine removes the old resin at once, but sometimes takes the varnish with it. For the inside, get a handful of rice, steep it in solution of sugar and water 5 minutes, strain off, and nearly dry the rice till just sticky. Put in at soundholes and shake till tired. This will pick up all dirt, then turn out.

Violin Bows.—(1) Take a small piece of flannel, wet it (cold process), well rub it with best yellow soap, double it, holding the hair gently between the finger and thumb, rub gently till clean, using plenty of soap;

rinse flannel, wipe off, then wipe dry with a piece of calico or linen; in an hour afterwards it will be ready for the resin. (2) A solution of borax-and-water.

Wall-papers.—To remove oil stains, or marks where people have rested their heads, from wall-papers, mix pipeclay with water to the consistency of cream, lay it on the spot, and allow it to remain till the following day, when it may be easily removed with a penknife or brush.

Zinc Vessels.—Zinc articles, if small, can be cleaned by being pickled in spirits of salts (hydrochloric acid) with water added, till the articles are nicely cleaned, in about three minutes, without being too strongly attacked, then washed and dried. Large articles like refrigerators are cleaned by being rubbed with a swab, dipped in raw spirits, then washed with water, and finished with whiting.

CONFECTIONERY.—The foundation of all kinds of confectionery is sugar, clarified, and boiled to different degrees by means of a special stove.

Stove.—The confectioners' stove is generally built like a cupboard in a recess in the wall of the bakehouse. The sides are of brick, or of wood lined with tin or sheet-iron, to preserve the heat, with strips of wood fastened about 4 in. apart, to support trays or shelves for drying the various goods; also a few movable iron network shelves for holding candy pots, arranged so that they can be tilted bodily. The door must shut close, and a smaller door or ventilator should be made in it near the top. The cupboard is heated by a stove of any desired pattern, or even by a pot of hot embers or charcoal.

Clarification.—For every 6 lb. of raw sugar required, take 1 qt. of water, the white of an egg, and about ½ teacupful of bullocks' blood. Less than 1 pint will suffice for 1 cwt.; but if a very fine, transparent, and colourless syrup is required, use finely powdered ivory-black instead of the blood. Put the white of egg in the water and whisk to a froth, then add the black and sugar, place the pan containing the ingredients on the stove-fire, and stir them well with a spatula, until the sugar is dissolved and nearly boiling. When ebullition commences, throw in a little cold water; this causes the coarser parts to separate more freely, and the impurities attach themselves to the clarifying matter used; continue for 5 minutes, using about 1 pint of water to every 6 lb. of sugar, until the dross is discharged, and there remains a fine clear syrup. Place the latter beside the stove, and carefully remove with a skimmer the scum which forms on the top: it may also be taken off as it rises, but it is best to let it remain a short time after it is clarified. When charcoal (black) is used, it must be passed through a filtering-bag made of thick flannel, in the shape of a cone, having a hoop fastened round the top to keep it extended, and to which strings are sewn that it may be tied or suspended in any convenient manner: what runs out at first will be quite black; return this again into the bag, and continue doing so until it runs fine and clear. A little lime or any other alkali, added to the sugar with the water, will neutralize the acid which raw sugars contain, and they will be found to stand better after they have been manufactured, by not taking the damp so soon.

Loaf-sugar is usually clarified by white of egg mixed with water, without other assistance. When it is necessary to have a very fine sparkling grain, break the lump into small pieces and put in a preserving-pan, with sufficient water to dissolve it, in which has been mixed the white of an egg and powdered charcoal, as for raw sugar, following instructions already given. After the sugar has been drained from the bag, pass some water through to take off any which may be left in the charcoal, and use for dissolving more sugar. The scum is reserved, when charcoal (black) is not used, to mix with articles of inferior quality.

Boiling degrees.—There are 7 essential degrees in boiling sugar: some authors give 13, but 9 may be admitted. They are:—(1) small thread, (2) large thread, (3) little pearl, (4) large pearl, (5) the blow, (6) the feather, (7) ball, (8) crack (9) caramel.

Syrup.—This term embraces the first 4 degrees, which are ascertained as follows. Place the clarified syrup on the fire, let it boil a little, dip the top of your finger in the boiling syrup, and on taking it out apply it to the top of your thumb; on separating them, a small string will be drawn out a little distance, about as fine as a hair, which will break and resolve itself into a drop on the thumb and finger ("small thread"). Continue the boiling a little longer, repeat the same operation as before, and a larger string will be drawn "large thread"). Separate the finger from the thumb as before, and a large string may be drawn, which will extend to nearly the distance the fingers may be opened ("little pearl"). The finger may now be separated from the thumb to the greatest extent before the thread will break ("large pearl").

Crystallization.—This includes the degrees of "blow" and "feather."

The principles of the operation are these. First, as in the case of syrup, when the water has absorbed as much sugar as it is capable of containing in a cold state, by boiling, a portion of the water is evaporated, and sugar remains in excess, which, when exposed to a less degree of heat, separates itself, and forms crystals on any surface presented to it. But if it is exposed too suddenly to cold, or disturbed in its action by being shaken, or if the boiling has been continued too long, the crystals will run hastily together, forming a mass or lump. To obtain crystals in perfection, the boiling must be gradual, and continued only till a few drops let fall on a cold surface show a crystalline appearance, or, after being removed from the fire, a thin skin forms on the surface. The syrup is then taken from the fire and placed in a less hot but not cold place, and covered or put into a stove or closet to prevent the access of cold air. A few drops of spirits of wine, added when the sugar has attained the proper degree, will conduce to more perfect crystalline form. It must be used with caution, as too much will cause the syrup to grain.

To ascertain the degree of the blow, continue the boiling, dip a skimmer in the sugar and shake over the pan, then blow through the holes, and small bubbles or air bladders are seen on the other side. For the "feather," dip the skimmer again into the sugar, and blow through the holes as before, and the bubbles will appear larger and stronger. Or, on giving the skimmer a sudden jerk, so as to throw the sugar from you, when it has acquired the degree, it will hang from the skimmer in fine long strings.

Candy.—After passing the degree of "feather," sugar is inclined to "grain" or "candy," and will form a powder if agitated or stirred; for as the boiling is continued, the water evaporates until none is left to hold the sugar in solution; therefore the latter returns to the state it was in before the solvent was added. The water, being evaporated by boiling from the last degree, leaves a thin crust of crystals round the sides of the pan, which shows it has attained the candy height; this crust must be carefully removed, as it forms, with a damp cloth or sponge, or the whole mass will candy if suffered to remain.

The "ball" degree can be ascertained in the following manner. Provide a jug of clean cold water, and the stem of a clean tobacco pipe or a piece of round stick. First dip it in the water, then in the sugar, and again in the water as speedily as possible; take off the sugar which has adhered, and roll it into a ball between the finger and thumb in the water. If it forms a large ball which will bite hard and adhere to the teeth, it is termed "large ball."

For "crack," follow the directions given for "ball." Slip the sugar off the pipe, or stick, still holding it in the water, then press it between the finger and thumb: it breaks short and crisp, with a slight noise.

To obtain "caramel" requires care and attention, and frequent trial. Try as before, and let the water be quite cold. On taking it off the pipe, it snaps like glass, with a loud noise; it will also assume a beautiful yellow colour; after this it will speedily burn, taking all hues from brown to black. To prevent burning, dip the bottom of the pan into a pail of cold water as soon as it comes to caramel; also be careful that the flame of the fire does not ascend the sides of the pan.

When boiling sugar, keep the top of the pan partially covered from the time boiling commences until attaining the ball or crack; the steam which rises, being thrown to the sides, prevents the formation of crust or crystals. To prevent graining, add a little acid when at the crack—a tablespoonful of common vinegar, 4 or 5 drops of lemon-juice, or 2 or 3 drops of pyroligneous acid: this is termed "greasing"; too much acid will grain it, and prevent boiling to caramel. A little butter added when it commences boiling will keep it from rising over the pan, and prevent graining. About as much cream of tartar as may be laid on a sixpence, added to 7 lb. of sugar with the water, or equal quantities of cream of tartar and powdered alum, added at the boiling stage, will also stop candying. Sugar is very liable to grain if poured on a hot slab, as may easily happen after several casts have been worked off. When sugar has been boiled or warmed several times, it is very apt to "run" and become sticky in a damp atmosphere. Acids in excess have the same effect. If a panful should pass the degree intended to be boiled at, add a little water and boil again.

Every intelligent confectioner now uses a thermometer to guide him in boiling his sugar, the most common form in this country being Fahrenheit's. The temperature for "syrup" ranges from 215° to 230° F. (102° to 110° C.); "blow" and "feather" mark about 235° F. (113° C.); "ball" reaches 240° F. (115½° C.); "crack" requires about 252° F. (122° C.); and "caramel" follows at 260° F. (127° C.).

Cakes.—*Bordeaux or Parisian.*—Make a mixture as for pound-cakes, leaving out the fruit, peel, and spices; bake in a round or oval hoop. When baked and cold, cut into slices ½ in. thick; spread each slice with jam or marmalade. The outside of the cake may be cut round, or fluted to form a star; and the centre of the cake is occasionally cut out to about 1½ in. from the edge, leaving the bottom slice whole: this may be filled with preserved wet or dry fruits, creams, or a trifle. The top is ornamented with piping, wet or dry fruits, and peels, or piped with jam and icing.

Pound.—The following table gives the ingredients necessary for rich pound-, Twelfth-, or bride-cakes of different prices:—

Ingredients.	10*s.* 6*d.*		12*s.*		15*s.*		18*s.*		1*l.* 1*s.*		1*l.* 11*s.*		2*l.* 2*s.*	
	lb.	oz.	lb.	oz	lb.	oz.	lb.	oz.	lb.	oz.	lb	oz.	lb	oz
Butter	0	11	0	13	1	1	1	4	1	6	2	1	2	12
Sugar	0	7	0	8	0	10	0	12	1	0	1	6	1	12
Currants	1	4	1	6	1	10	2	0	2	8	3	12	5	0
Orange, lemon, and citron (mixed)	0	6	0	7	0	8	0	10	0	12	1	2	1	8
Almonds	0	1½	0	2	0	2	0	3	0	3	0	4	0	6
Mixed spice*	0	0½	..		0	0¾	..		0	1	0	1½	0	2
Flour	0	11	0	13	1	1	1	4	1	6	2	1	2	12
Eggs (number)	6		7		9		10		12		18		24	
Brandy, or brandy and wine	Wine		glass		full		..		¼ pt.		..		½ pt.	

* Nutmegs, mace, and cinnamon, of each equal parts, in powder.

These proportions allow for the cake being iced. If more sugar is preferred, it may be the same as the butter; less is used that the cake may be light, and to allow for the sweet fruit. Double the quantity of almonds may be used. To make: warm a smooth pan, large enough for the mixture; put in the butter, and reduce it to a fine cream, by working it about the pan with your hand. In summer the pan need not be warmed; but in winter keep the mixture as warm as possible, without oiling the butter. Add the sugar and mix it well with the butter, until it becomes white and feels light in the hand. Break in 2 or 3 eggs at a time, and work the mixture well before more is added. Continue doing this until all are used and it becomes light; then add the spirit, currants, peel, spice, and almonds, most of the almonds being previously cut in thin slices, and the peel into small thin strips and bits. When these are incorporated, mix in the flour lightly; put it in a hoop with paper over the bottom and round the sides, and place on a baking-plate. Large cakes require 3 or 4 pieces of stiff paper round the sides; and if the cake is very large, a pipe or funnel, made either of stiff paper or tin, and well buttered, should be put in the centre, and the mixture placed round it; this is to allow the middle of the cake to be well baked, otherwise the edge would be burnt 2 or 3 in. deep before it could be properly done. Place the tin plates containing the cake on another, the surface of which is covered 1 or 2 in. thick with sawdust or fine ashes to protect the bottom. Bake it in an oven at a moderate heat. The time required to bake it will depend on the state of the oven and the size of the cake. A guinea cake in an oven of a proper heat will take 4 to 5 hours. When the cake is cold, proceed to ice it. Wedding-cakes have generally, first, a coating on the top of almond icing; when this is dry, the sides and top are covered with royal or white icing. Fix on gum paste or other ornaments whilst it is wet; and when dry, ornament with piping, orange-blossoms, ribbon, &c.; the surface and sides are often covered with small knobs of white sugar candy whilst the icing is wet. Twelfth-cakes are iced with white or coloured icing, and decorated with gum paste, plaster ornaments, piping-paste, rings, knots, and fancy papers, &c., and piped.

Italian Bread.—Take 1 lb. butter, 1 lb. powdered loaf-sugar, 18 oz. flour, 12 eggs, ½ lb. citron and lemon-peel. Mix as for pound-cake. If the mixture begins to curdle, which is most likely from the quantity of eggs, add a little of the flour. When the eggs are all used, and it is light, stir in the remainder of the flour lightly. Bake in long, narrow tins, either papered or buttered; first put in a layer of the mixture, and cover with the peel cut in large thin slices; proceed in this way until ¾ full, and bake in a moderate oven.

Rice Pound-cake.—Take 1 lb. butter, 1 lb. powdered loaf-sugar, 12 oz. flour, ½ lb. ground rice, and 12 eggs. Mix as Italian bread, and bake in a papered hoop. If required with fruit, put 2 lb. currants, ¾ lb. peel, 1 grated nutmeg, and a little pounded mace.

Savoy (hot mixture).—Take 1 lb. powdered loaf-sugar, 1 pint good eggs, and 14 oz. flour. Warm a pan, free from grease, with the sugar in it, in the oven until you can scarcely bear your hand against it; then take out and pour in the eggs: whisk with a birch or wire whisk until quite light and cold, when it will be white and thick. If it should not whisk up well, warm again and beat as before; or it may be beat over the stove fire until it is of the warmth of new milk. When finished, sift the flour and stir it in lightly with a spoon, adding a few drops of essence of lemon to flavour it. Butter some tin or copper moulds regularly, with rather less on the top than the sides. Dust with loaf-sugar sifted through a lawn sieve Knock out all that does not adhere, and again dust with fine flour; turn out, and knock the mould on the board. Tie or pin a piece of buttered paper round the mould, so as to come 2 or 3 in. above the bottom. Fix the mould in a stand and nearly fill it. Bake in a moderate oven. When done, the top should be firm and dry. Try it by pushing in a small piece of stick or whisk, and if it comes out dry, it is done. The surface of the cake should be quite smooth. There is as much art in buttering the mould properly as in preparing the mixture.

Cold mixtures.—Separate the yolks from the whites when you break the eggs. Put the yolks into a clean pan with the sugar, and the whites in another by themselves. Let the pans be quite free from grease. If they are rubbed round with a little flour, it will take off any which may be left. Wipe out with a clean cloth. Beat up the yolks and sugar by themselves, with a wooden spoon, and afterwards whip up the whites to a very strong froth. If they should happen to be rather weak, a bit of powdered alum may be added. When the whites are whisked up firm, stir in the yolks and sugar. Sift the flour and mix in lightly with the spatula, adding a little essence of lemon to flavour. Fill the moulds and bake as before. When cakes are made in this way, the eggs should be quite fresh and good, otherwise the whites cannot be whipped up. When weak, pickled eggs are used. A good method is to beat the eggs first by themselves, over a fire, until they are warm; then add the sugar, and whip it over the fire until again warm, or make as for hot mixtures, and heat twice.

Almond Savoy and Almond Hearts.—Take 1 lb. blanched sweet almonds (4 oz. of them may be bitter), 2 lb. sugar, 1 pint yolk of egg, $\frac{1}{2}$ pint of whole eggs, 1 lb. flour, and the whites of 12 eggs beaten to a firm froth. Pound the almonds with the sugar in a mortar, and sift through a wire sieve, or grind in a mill, and mix with the sugar in the mortar. First mix the whole eggs well with the almonds and sugar, then add the yolks by degrees, stirring until quite light; then mix in the whites, and afterwards the flour lightly; prepare some moulds as for Savoy cakes, or only butter them. Fill the moulds $\frac{3}{4}$ full, and bake in a moderate oven. For almond hearts, butter some tins in the shape of a heart, but without bottoms; cover a baking-plate with paper; place the tins on it, and fill nearly $\frac{3}{4}$ full with the mixture; dust a little sugar on the top, and bake in a moderate oven.

Venice.—Cut a Savoy cake in slices $\frac{1}{2}$ to $\frac{3}{4}$ in. thick, in a parallel direction from the bottom to the top; spread each slice with raspberry or apricot jam, or some of each alternately, or any other sort of preserve. Replace each piece in its original form; when completed, make an icing as directed for cakes, with 4 whites of eggs to 1 lb. sugar, which will make it rather thin. It may be coloured with cochineal, &c.; spread it over the cake, which, being thin, will run into the flutes and mouldings of the cake, when it will appear of the same form as before. Let dry in the mouth of the oven, but be careful it does not get discoloured. When dry, ornament with piping. Savoy cakes are often done in the same manner, without being cut in slices, to ornament them; or they may be done without icing, and either piped, or ornamented with gum paste borders, &c., which are fixed on with dissolved gum arabic. Volutes or high and projecting figures are supported with pieces of small wire.

Savoy cake to represent a melon.—Bake a cake in a melon-mould; when cold, cover with icing as for a Venice cake. Whilst wet, stick on pieces of loaf-sugar, to imitate the surface of the melon. Strew over some yellow and green sugar-sands; or paint when dry to imitate nature. Form the stalk and leaves out of gum paste, and fix in the centre, on the top.

Savoy cake to imitate a hedgehog.—Bake a cake in a mould of that form; blanch some Valentia or Jordan almonds; cut them into small fillets and stick them over the surface, to form the quills or prickles of the hog. Put in two currants for the eyes.

Wafers.—Take 4 oz. sugar, 4 oz. butter, 8 oz. flour, the yolk or white of 1 egg, and $\frac{1}{2}$ teacupful of milk or water. Melt the butter in the water; mix the egg, sugar, and flour together, adding, by degrees, the melted butter and water; or, instead of the butter, it may be made into a thin batter with cream, and a little orange-flower water, or any other essence, to flavour. The mixture may be coloured. Make the wafer-tongs hot over the hole of a stove or clear fire. Rub the inside surfaces with butter or oil, put in a spoonful of the batter, and close the tongs immediately; put them on the fire, turning them occasionally until the wafer is done, which a little practice will soon enable you to ascertain; roll the wafers on a small round stick, stand on their ends in a sieve, and put in the stove to dry; serve with ices.

Candied Sugar.—Provide a round mould, smaller at bottom than top, of any size, made of tin or copper, with holes round the sides about 3 in. asunder, so as to fasten strings across in regular rows from the top to the bottom, leaving sufficient room for the sugar to crystallize on each string without touching, or it will form a complete mass; paste paper round the outside to prevent the syrup from running through the holes. Have the mould clean and dry; take sufficient clarified syrup to fill, boil to "blow" or "feather," and add a little spirits of wine; remove from the fire, and let rest until a thin skin is formed on the surface, which you must carefully remove with a skimmer; pour into the mould, and place in the stove, where let it remain undisturbed for 8 or 9 days, at 90° F. (32° C.) or half that time at 100° F. (38° C.); make a hole, and drain off superfluous sugar into a pan placed below; let drain quite dry, which will take about 12 hours; wash off the paper from the mould with boiling water, place near the fire, and keep turning to warm it equally all round; turn up and strike the mould rather hard upon the table, when the sugar will relieve itself and come out; put on a stand or sieve in the stove, raise the heat to 120° F. (49° C.), and let remain until perfectly dry. The heat of the stove must be kept regular and constant; this can easily be accomplished at small expense with many of the patent stoves now in general use, and without causing any dust. A thermometer should be so placed that the heat may at all times be ascertained without opening the stove. Colour with prepared cochineal, or other liquid colour, or by grinding any particular colour with the spirits of wine and adding it to the syrup before it comes to the feather.

Chain with Liqueur Rings.—Have some moulds to form the impressions in powder, as in the preceding, in the shape of the links of a chain; fill with syrup at the blow, as before, and put in the stove for a day; when hard and fit to be taken out, place on their ends in the powder; have another mould of a link in two halves, and with this form the impressions between the others, so as to complete; fill, and finish as before.

Crystallized Chocolate.—Prepare some sugar and pour into the box. When a thin crust is formed on the top, make a hole on one side, and push the articles previously shaped with chocolate, as for drops, gently under with your finger; put them in the stove to crystallize, as other articles. After the syrup is drained off, and the articles dried, they must remain until quite cold before being turned out, as the chocolate continues soft for some time.

Crystallized Fruits.—Have a square or round tin box, smaller at bottom than top, with wire gratings made to fit at convenient distances, and having a hole with a tube or pipe to admit a cork, and drain off the syrup. Take any preserved fruit wet, drain from the syrup, and dip in lukewarm water to take off any syrup which may adhere; dry in the stove; when dried, place in layers on the gratings, side by side, so as not to touch each other; continue in this manner with any sort of fruit until the box is full; then fix the whole with a weight, to keep it steady. Boil sufficient clarified sugar to fill the box to the degree of "blow," add a little spirits of wine, and remove from the fire. When a thin skin has formed on the top, remove carefully with a skimmer, and pour the sugar into the mould;

place in the stove at 90° F. (32° C.), and let remain for 12 hours; drain off the syrup into a pan from the tube at bottom, and let remain in the stove until quite dry; turn out by striking the box hard upon the table, separate carefully, and put in boxes with paper between each layer. When different fruits, paste, knots, &c., are mixed together indiscriminately, it is termed mille-fruit candy. Any sort of fruit or gum pastes, when thoroughly dried, may be crystallized in the same manner. When the syrup is drained off, if the crystals are not large enough, another lot of syrup may be prepared and poured over; let remain in the stove for 7 or 8 hours, then drain and finish as before. If small pieces of stick are pushed down at each corner, or in any other vacancy, when filling the mould, one may be withdrawn at any time to ascertain the size of the crystals, which will save the trouble of giving a second charge of sugar.

Liqueur Rings, &c.—These are all made after the same manner. A square box is filled with very dry starch powder, or very fine and dried sugar. The depth of the box should suit the articles to be made. Shake the box, or pass a knife repeatedly through the powder, that it may be solid; smooth the surface with a straight piece of wood; have a thin piece of flat board, on which is fastened a number of little devices, about 1 in. apart, and to suit the width of the box; these may be made of lead, plaster, or wood, in the form of rings, diamonds, stars, bottles, scissors, harps, shoes, or any other form fancy may suggest; make the impressions in the powder in regular rows, until the box is full; then prepare some sugar, boiling it to the blow, and flavouring with any sort of spirit or liqueur, such as brandy, rum, noyau, Maraschino, cinnamon, rosolis, &c., colouring the syrup accordingly. It should be prepared in a pan with a lip. When a thin skin has formed on the top, place a cork in the lip of the pan, but not to close it, allowing a space for the sugar to run out, the cork being merely to keep back the skin; then fill the impressions you made in the powder and place them in the stove at 90° F. (32° C.); let remain a day, then take out, and their surfaces will be found quite hard and solid; brush the powder from them with a light brush, when they may be painted, crystallized, or piped. Many of these bon-bons are beautifully piped and coloured to represent dogs, horses, costumes, and theatrical characters; the fur on the robes is imitated with white or coloured sugar in coarse grains, and lace-work is done by means of a pin. Liqueur drops are made with the impression of half a ball to any required size, as other forms. If the flat parts of two are moistened, put together, and dried in the stove, they will form drops perfectly round.

Candy.—Articles that come under this head are made from sugar brought to the ball, and grained by rubbing against the sides of the pan.

Artificial Fruit, Eggs, &c.—Prepare plaster moulds from the natural objects; make in 2, 3, or more pieces, so as to relieve freely, and have a hole at one end into which the sugar may be poured; let them be made so that the parts fit together exactly; for this purpose, have 2 or 3 round or square indentations on the edge of one part, so that the corresponding piece, when cast, will form the counterpart, which may at all times be fitted with precision. Let the object you would take the cast from be placed in a frame of wood or stiff paper; embed a part in fine sand, soft pipeclay, or modelling wax, leaving as much of the mould exposed as you wish to form at one time, and oil with sweet-oil; mix some prepared plaster with water, to the consistency of thick cream, and pour over; when this is set, proceed with the other portions in the same manner until complete. Let dry and harden for use. Take sufficient syrup (clarified with charcoal) to fill the mould, and boil to small ball; rub some against the side, so as to grain it; when it turns white, pour into the moulds; take out when set, and put into the stove, at a moderate heat, to dry. The moulds must be soaked for an hour or two in cold water previously to their being used, which will be found better than oiling them, as it keeps the sugar delicately white, while oil does not. Colour according to nature with liquid colours and camel's-hair pencils, or the usual pigments sold in boxes may be used. If a gloss is required, the colours should be mixed with a strong solution of gum arabic or isinglass, to the desired tint. Eggs and fruit may be made as light and apparently as perfect as nature, by having moulds to open in two, without any orifice for filling them. Fill one-half with the grained sugar, immediately close the mould, and turn it round briskly that it may be equally covered all over. To accomplish this, it is necessary to have an assistant.

Burnt Almonds.—Take fine Valencia or Jordan almonds, and sift all the dust from them; put a pint of clarified syrup into the pan for each lb. of almonds, and place it with the almonds on the fire; boil to ball, then take off and stir the mixture well with a spatula, that the sugar may grain and become almost a powder, whilst each almond has a coating. Put into a coarse wire or cane sieve, sift all the loose sugar from them, and separate those which stick together. When cold, boil some more clarified syrup to feather, put in the almonds, give 2 or 3 boils in it, take from the fire, and stir with the spatula as before, until the sugar grains; sift and separate, and keep in glasses or boxes. A third coat may be given in the same manner as the second, if they are required large.

Red.—The same as the last, using prepared cochineal to colour the syrup whilst boiling.

Common.—These are made with raw sugar and skimmings. Put some water with the sugar to dissolve it; when near boiling, add the almonds, and let boil in it until it comes to small ball; or when the almonds crack, take from the fire, and stir with a spatula until the sugar grains and becomes nearly a powder; put into a sieve, and separate the lumps.

Best Burnt Almonds—Red.—For each lb. of sifted almonds, use 2½ lb. loaf-sugar, made into a syrup. A round-bottomed copper pan is best for making these in. The almonds may be boiled in the sugar until they crack, before being taken from the fire to be stirred and separated for the second coat; or, when the sugar is boiled to ball, the almonds may be put in; then take from the fire, and stir well with a spatula, that the sugar may grain, and each almond have a coating. Put the pan on the fire again, and keep constantly stirred, that the loose sugar may melt and burn about them of a fine brown. Either way will give the burnt flavour, from which they take their name. Turn into a coarse sieve, sift all the loose sugar from them, and separate those that stick together. Boil the same quantity of clarified syrup as before to feather and colour it to the desired shade with prepared cochineal. Let it attain the same degree again before taking the syrup from the fire, then put in the almonds and stir them as before until the sugar grains, and again sift and separate. The sugar for the third coating must not be boiled quite so high as the last, and there must be only sufficient to just cover them. Immediately the sugar begins to grain about them, turn out on the stone, and cover with a pan or cloth. After a few moments, separate and put in boxes or glasses, when cold. The colour of these almonds is considered to be much brighter when the syrup is boiled rather higher than the required degrees for the second and third coats, and the colour added to reduce it, after it is taken from the fire.

Coco-nut Ice, or Candy.—Finely grate the inside of a coco-nut; mix 6 or 8 oz. of the grated nut with 1 lb. sugar; use water to moisten the sugar in the proportion of 1 pint to 3 lb. Boil to bare crack, grain the sugar by rubbing some against the side of the pan, and pour into oiled or buttered tins. Some give an additional flavour by adding a little raspberry jam, or orris powder (which will also give somewhat the flavour of a raspberry, if a little tartaric acid is used with it). With the jam more particularly it forms a most delicious compound. It should be coloured with prepared cochineal to give the red colour of raspberries, otherwise it should be white. Machines are now generally used for preparing the coco-nut.

Coltsfoot or Horehound Candy.—Make a strong infusion of the herbs, and use for dissolving the sugar, instead of taking syrup. Raw sugar is mostly used. Boil to the ball, grain and finish as ginger candy.

Filberts and Pistachios.—These are done the same as burnt almonds, but they are usually denominated prawlings, the nuts being only put into the sugar for 2 or 3 minutes before it is taken from the fire, and stirred.

Ginger Candy.—Clarified syrup, boiled to the ball; flavour either with essence of ginger, or powdered root; then with a spoon or spatula rub some against the side of the pan until it turns white; pour into small square tins, with edges or paper cases which have been oiled or buttered, and put in a warm place or on a hot stone, that it may become dappled. The syrup should be coloured yellow, whilst boiling, with a little saffron.

Lemon Prawlings.—As orange.

Orange Prawlings.—Take 4 or 5 China oranges, and cut off the peel in quarters, or small lengths; take off all the pith or white part of the peel, leaving only the yellow rinds, and cut into small pieces, about an inch long, and the size of pins. Have about a pint of clarified sugar boiling on the fire; when it comes to the blow, put in the pieces of peel, and let boil until the sugar attains small ball; take off, and stir with the spatula until the sugar grains and hangs about them; sift off the loose sugar: when cold, separate and keep in a dry place.

Peppermint, Lemon, and Rose Candy are made as ginger candy, colouring the lemon with saffron, and the rose with cochineal.

Plum Candy.—To 3 lb. sugar put 1 pint water, boil to bare crack, take from the fire, and beat with a spatula as in whisking eggs; as soon as it begins to froth or rise in the pan, pour into tins previously buttered and covered with split almonds, currants, or stoned raisins, and immediately cover it with the pan turned upside down. It may be coloured in the boiling with cochineal, or saffron. Flavour the white with peppermint, or essence of bitter almonds; pink, with otto of rose; and yellow, with essence of lemon or ginger.

Sweet-Flag Candy.—Sweet-flag candy is relished by all lovers of sweetmeats, and it is a valuable aid to digestion. Being eaten greedily by children, it is often better than other medicine. A bit held in the mouth when one is caring for the sick will often counteract the effect of contagious germs. To prepare it, take fresh, healthy roots of sweet-flag, and after a careful washing, cut in slices ½ in. thick. Put into a stew-pan or bright basin, and pour a little more cold water over than will cover them. Set on the stove and heat slowly; when the water boils, turn it off. If the candy is desired for medicine, quite enough of the strength has been removed, but for a sweetmeat it is better if boiled up and the water turned off 4 or 5 times. Now measure the sliced roots, and to each 2 cupfuls allow 1½ cupfuls of white sugar; turn on water enough to cover, return to the stove and simmer slowly, stirring often until the water has quite boiled away; then turn out on buttered plates, and stir frequently until dry. The long simmering after the sugar is added makes the roots quite tender, and the candy will keep fresh and nice for years. (*Country Gentleman.*)

Chocolate.—*Roasting.*—Take sufficient nuts to cover the bottom of an iron pot 2 or 3 in. deep, place on the fire to roast, stirring constantly with the spatula that the heat may be imparted equally. A coffee-roaster answers for this purpose, taking care not to torrefy them too much, as the oil of the nut suffers thereby, and it becomes a dark brown or black, grows bitter, and spoils the colour of the chocolate. Musty or mouldy nuts must be roasted more than the others, so as to deprive them of their bad taste and smell. It is only necessary to heat them until the skin will separate from the kernel on being pressed between the fingers. Remove from the fire, and separate the skins. If a large quantity, put them in a sieve which has the holes rather large, but not so much as to allow the nuts to pass through; then squeeze or press in your hands, and the skins will pass through the meshes of the sieve; or, after being separated from the nuts, they may be got rid of by winnowing or fanning in a similar manner to corn. When separated, put again on the fire, stirring constantly until warmed through, without browning. When they are heated enough, the outside appears shiny; winnow again, to separate any burnt skin which may have escaped the first time.

Making.—Have an iron pestle and mortar, a stone of close grain and texture, and a rolling-pin of the same material or of iron. The stone must be fixed so that it can be heated from below with a pot of burning charcoal. Warm the mortar and pestle by placing on a stove, or by charcoal, until they are so hot that you can scarcely bear your hand against them. Wipe the mortar clean, and put a convenient quantity of prepared nuts in it; pound until they are reduced to an oily paste into which the pestle will sink. If required sweet, add ½ to ⅓ of its weight of powdered loaf-sugar; mix well together, then put in a pan in the stove to keep warm. Take a portion and roll or grind well on the slab with the roller (both being previously heated like the mortar) until it is reduced to a smooth impalpable paste, which will melt like butter in the mouth. Put in another pan, and keep warm until the whole is similarly disposed of; then place again on the stone, not quite so warm as previously, work over again, divide into pieces of 2, 4, 8, or 16 oz. each, and put in moulds. Give a shake, and the chocolate will become flat; when cold, it easily turns out. The moulds may be of tin or copper, and of various devices.

Bayonne or Spanish chocolate is generally the most esteemed. Its superior quality is attributed by some to the hardness of the stone employed in making it, which does not absorb the oil from the nuts. No pestle and mortar is used, but the nuts are levigated on the stone, which is fixed on a slope; and in the second pounding or rolling, the paste is pressed closely on the stone, so as to extract the oil, which runs into a pan containing the sugar to be used; the oil of the cacao and the sugar are well mixed with a spatula, again mixed with the paste on the stone, and finished.

Chocolate Drops with Nonpareils.—Have some warm chocolate, as for pistachios; some add a little butter or oil to make it work more free; make into balls about the size of a small marble, by rolling a little in the hand, or put some of the paste on a flat piece of wood, on which to form, and take off with a knife. Place on sheets of white paper about 1 in. apart. When the sheet is covered, take by the corners and lift up and down, letting it touch the table each time, which will flatten them; cover the surface entirely with white nonpareils, and shake off the surplus ones. When the drops are cold, they can be taken off the paper easily. The bottom of the drops should be about as broad as a sixpence. Some of them may be left quite plain.

Chocolate Harlequin Pistachios.—Warm some sweet chocolate by pounding in a hot mortar; when reduced to a malleable paste, take a little, and wrap round a blanched pistachio nut, roll in the hand to form it as neat as you can, throw it in some nonpareils of various colours; let it be covered all over. Dispose of the whole in the same manner; fold them in coloured or fancy papers, with mottoes; the ends should be cut like fringe. Almonds may be done the same way, using vanilla chocolate, if preferred.

Cinnamon, Mace, or Clove Chocolate.—These are made the same as vanilla, using about 1½ to 2 oz. of any powder spice to that quantity, or sufficient of the essential oils to flavour.

Stomachic Chocolate.—Take 4 oz. chocolate prepared without sugar, 1 oz.

vanilla, 1 oz. powdered cinnamon, 48 gr. ambergris, 3 oz. sugar; warm the paste by pounding in the heated mortar, or on the stone, add aromatics in powder to the sugar, and mix well with the paste; keep closed in tin boxes. About 12 gr. of this is put into the *chocolate-pot* when it is made, giving an agreeable and delightful flavour, and rendering it stomachic. It may also be used for flavouring chocolate tablets.

Vanilla Chocolate.—Take 10 lb. prepared nuts, 10 lb. sugar, 2½ oz. vanilla, 1 oz. cinnamon, 1 dr. mace, and 2 dr. cloves. Prepare nuts according to directions given. Cut the vanilla in small bits, pound fine with part of the sugar, and mix with the paste; boil about ½ the sugar to "blow" before adding to the chocolate, otherwise it will eat hard. Proceed as before, and either put in small moulds or divide in tablets, which are wrapped in tinfoil. This is ordinary "eatable" chocolate.

Comfits.—These are made in a copper comfit-pan, attached to a bar, having chains at each end, with a hook and swivel in the centre, by which it is suspended from the ceiling about breast high over a stove or charcoal fire. Steam pans are now used in large factories. A preserving-pan containing clarified syrup is placed inside the stove, or over another fire, that it may be kept hot, but not boiling; a ladle for throwing syrup into the pan, and a "pearling cot," are also needed. This last somewhat resembles a funnel without the tube, and having a small hole in the centre with a pointed spigot fitted into it, which regulates the syrup run out. A piece of string tied several times across the centre of the top of the cot, and twisted with the spigot, allows it to be adjusted.

Almond.—Sift Valencia almonds in a cane or wicker sieve, pick out any pieces of shell and any very small or large almonds, using those which are near of a size; take about 4 lb., put into the comfit-pan, and proceed as for caraways (1); or they may first have a coating of dissolved gum arabic; rub well about the pan with the hand, and give a dust of flour; then pour on a little syrup at small thread, work and dry well, give 3 or 4 more charges, and a charge of gum with a dust of flour. Proceed thus until they are ⅓ the required size, then dry for a day, and proceed and finish as for caraway comfits. For cheaper comfits, more gum and flour are used.

Barberry.—Pick the barberries from the stalks, and dry on sieves in a hot stove; when dry, put about 2 lb. into the comfit-pan, and proceed as for almond comfits, giving first a charge of gum and flour, and finish as others. Make of a good size, and quite smooth; finish with very white loaf sugar syrup.

Caraway.—(1) Sift 2 lb. caraway seeds in a hair sieve to free them from dust, put into the comfit-pan, and rub well about the bottom with your hand until quite warm; have some clarified loaf sugar syrup boiled to "small thread"; give a charge by pouring over about 2 tablespoonfuls; rub and shake well about the pan, that they may take the sugar equally, until quite dry. Be careful not to make them too wet in the first charges by using too much syrup, or they will lie in a lump and be difficult to part. It prevents sticking to pass the hand through them between every swing of the pan, and adds to their smoothness. Give 4 or 5 charges, increasing the quantity of syrup a little each time, and let each charge be well dried before another is given, dusting with flour at the last charge. Sift in a hair sieve, and clean the pan. Put in again, and give 4 or 5 charges more, with a dust of flour at the last; then sift, and clean the pan. Proceed thus until they are ⅓ required size. Put in the stove or sun to dry until next day; clarify and boil some sugar to large thread, keep warm as before, divide the comfits, and put part in the pan, so as not to have too many at one time; as they increase in size, divide into convenient portions, so as to work them properly without encumbering the pan. Give 4 or 5 charges of syrup, proceeding in the same manner as before, until they are ⅔ or more of the required size;

store until next day. Continue with each portion alternately, until all are done. On the third day, boil the syrup to small pearl, and give 8 or 10 charges as before, without using flour, lessening the quantity of syrup each time. Swing the pan gently, and dry each charge well. Put in the stove for ½ or 1 hour after each charge, and proceed alternately with each portion until finished, when they should be about the size of peas. Put in the stove for a day, then smooth with the whitest loaf sugar syrup boiled to small thread; add 2 or 3 tablespoonfuls of dissolved gum arabic to give a gloss. Give 3 or 4 charges with a very gentle heat, the syrup being cold and the pan scarcely warm. Work and dry each charge well before another is added; when finished, dry in a moderate heat. It is best to dry comfits in the sun, as it bleaches them. If the stove is at a greater heat than the sun on a moderately warm day, which is 70° to 80° F. (21° to 27° C.), it will spoil their whiteness. (2) Bath Caraways are made in the same way, but only half the size. (3) Gingerbread Caraways. Sift the seeds, and warm in the pan, as for (1). Have some gum arabic dissolved, throw in a ladleful, and rub well about the pan with the hand until dry, dusting with flour. Give 3 or 4 coatings in this manner, and then a charge of sugar, until the comfits are about ½ the required size. Dry for a day, give 2 or 3 coatings of gum and flour, finish by giving 3 or 4 charges of sugar, and dry. These are made about the size of Bath caraways. Colour some different colours, leaving the greatest portion white. (4) Pearled. When the comfits are about the size of Bath caraways, dry and pearl as cinnamon.

Cardamom.—Keep the seeds in their husks until used. They are often mixed with grains of paradise, which have not the same aromatic taste, and are more hot and spicy. Break the husks by rolling with a pin; separate the skins from the seeds, put 2 lb. into the comfit-pan, and proceed as for caraways (1). Make a good size, and quite smooth.

Celery.—Put 1 lb. celery seed into the pan, and proceed as for caraways (1), working up to the size of a large pin's head. Dry and pearl as cinnamon.

Cherry.—These are made from preserved cherries, dried. Roll in your hand to make quite round, dust with powdered loaf sugar, and dry again; then proceed as for barberry comfits. Other preserved fruit comfits may be made in the same manner.

Cinnamon.—Take 1 lb. cinnamon bark, and steep in water for a few hours to soften; cut into pieces about ½ in. long, and the size of a large needle. Dry in the stove. Put the pieces, when dry, into the comfit-pan, and pour on a little syrup, as for caraways (1), proceeding in the same way until they are ⅓ the required size. You must not use your hand for these as for caraways (1), as they are liable to break. Dry in the stove, then suspend the pearling cot; boil some clarified loaf sugar to large pearl, and fill the cot; put some of the prepared comfits in the pan, but not too many at a time, as it is difficult to get them to pearl alike. Keep the syrup at the boiling point; open the spigot of the cot so as to allow it to run in a very small stream or continued dropping; swing the pan backwards and forwards gently, and keep a stronger fire under the pan than otherwise. Be careful that the syrup runs so that it dries as soon as dropped, which causes the comfits to appear rough. If one cot full of sugar is not enough, put in more until they are the required size. When one lot is finished, put in sieves to dry, and proceed with another; but do not let them lie in the pan after you have finished shaking them. They will be whiter and better if partly pearled one day and finished the next. Use the best clarified sugar to finish.

Clove.—Flavour sugar gum paste with oil of cloves, and mould in the form of cloves. Dry and finish as others.

Colouring.—Put some of the comfits or nonpareils into the comfit-pan, shake or rub about until warm, add sufficient prepared liquid colour to give the desired tint; be careful not to make too wet, nor of too dark a colour; shake or rub well about, that they may be coloured equally; dry a little over the fire, put in sieves, and finish drying in the stove. Clean the pan for every separate colour.

Coriander.—Proceed as for caraways (1), working up to about the same size. Next day pearl to a good size, as for cinnamon.

Flavoured with Liqueurs. — Blanch some bitter almonds, or kernels of apricots or peaches; let soak in hot water for an hour, then drain and put into any sort of liqueur or spirit. Lower the strength of the spirit with water, that the kernels may imbibe it the better, cork the jug or bottle close, and let them infuse in it until the spirit has fully penetrated, which will be 14 or 15 days; take out, drain, and dry in a moderate heat; when dry, proceed as for almond comfits.

Ginger.—Flavour gum paste with powdered ginger, make into balls about the size of coriander seeds, or peas; dry, and proceed as for caraways (1). Colour yellow when finished.

Lemon Peel or Angelica may be made as orange. Let the strips of peel be about the size of the pieces of cinnamon, and thoroughly dried before working in the pan.

Nonpareils.—Pound loaf sugar, and sift through a fine wire sieve; sift what passes through in a lawn sieve, so that you have only the fine grain of sugar left without dust. Put about 2 lb. of this into the comfit-pan, and proceed as for caraways (1), working well with the hand until about the size of pins' heads.

Orange.—Cut preserved orange-peel into small thin strips; dry in the stove, and make as cinnamon comfits.

Raspberry.—Prepare gum paste with sugar, or the scrapings of the comfit-pan pounded and sifted through a lawn sieve. Flavour with raspberry jam, by mixing some with the paste. Colour with prepared cochineal; mould into the form of raspberries, and dry in the stove; when perfectly dry and hard, pearl as for cinnamon comfits, working them until the size of natural raspberries. Colour when dry with cochineal, as comfits.

Crack and Caramel.—These embrace all articles which eat short and crisp.

Acid Drops and Sticks.—Boil clarified sugar to crack, and pour it on an oiled marble stone; pound tartaric or citric acid to a fine powder, and strew about ½ or ¾ oz. of the former, according to its quality, and less of the latter, to 7 lb. sugar; turn the edges over into the middle, and mix the acid by folding over, or by working as dough is moulded, but do not pull it; put in a tin rubbed over with oil or butter, and place under the stove to keep warm; then cut off a small piece at a time, and roll into a round pipe; cut off in small pieces the size of drops, with shears, and let your assistant roll them round under his hand and flatten them. Mix with powdered sugar, sift from it, and keep in boxes or glasses. When flavoured with lemon, they are called lemon-acid drops; with otto of roses, rose-acid drops. The sticks are made in the same manner as the drops, without being cut into small pieces.

Almond Hardbake.—Oil a square or round tin with low edges; split some almonds and put in rows over the bottom, with the split side downward, until the surface is covered, boil some raw sugar to crack, and pour it over so as to cover the whole with a thin sheet of sugar. Coco-nut cut in thin slices, currant, and other candies, are made as the hardbake, except that the sugar is grained before it is poured over.

Almond Rock.—This is similar to nogat, and is made with raw sugar boiled to crack. Pour on an oiled stone, and fill with sweet almonds, either blanched or not; the almonds are mixed with the sugar by working them in with the hands, as you would mix anything into a piece of dough. If they were stirred into the sugar in the pan, it would grain, which is the reason why it is melted for nogat. Form the rock into a ball or roll, and make into a sheet about 2 in. thick, by rolling with a rolling-pin. The top may be divided into diamonds or squares by means of a long knife or piece of iron; when nearly cold, cut it into long narrow pieces with a strong knife or hammer.

Barley Sugar.—Boil clarified loaf sugar to crack or caramel, using a little acid to prevent graining; pour out on a marble slab, which has been previously oiled or buttered. This is occasionally flavoured with lemons. When required, pour a few drops of essential oil of lemon in the centre, before the edges are folded over, then cut into narrow strips with a large pair of scissors or shears. When nearly cold, twist, put into glasses or tin boxes, and keep closed to prevent the access of air. It is seldom boiled higher than crack, and saffron is used to make it the colour of caramel.

Barley Sugar Drops.—Boil sugar as for the preceding. Spread finely powdered and sifted loaf sugar on a table or tea-tray, with a piece of stick round at the end; make several holes, into which run the sugar from a lipped pan; or drop on an oiled marble slab with a funnel, letting only one drop fall at a time; or from the lip pan, separating each drop with a small knife or a straight piece of small wire. Take off the stone with a knife, mix with powdered loaf sugar, sift from it, and keep in glasses or tin boxes.

Barley Sugar Tablets or Kisses.—Spread sugar as for the last; have a piece of wood about 1½ in. thick, with the surface divided into 1-in. squares ½ in. deep; with this form the impressions in the sugar, and fill with sugar boiled as for drops, flavouring with essence of lemon; or it may be poured out in a sheet on an oiled marble slab, as for barley sugar, and when nearly cold divided into pieces with a tin frame, having small square divisions, when the whole sheet may be divided at once by pressing hard on it so as to cut it nearly through. When cold, separate, and mix with powdered sugar; take out and fold separately in fancy or coloured papers, with a motto on each. They are also occasionally made into balls, thus—First cast the sugar in a sheet on an oiled marble slab; when the edges are set, fold them in the middle, then oil a small square tin with edges to it, put the sugar in this, and place under the fire-place of the stove so as to keep warm; cut off a piece and roll into a pipe, then cut into small pieces with a pair of shears, and let your assistant roll it into small balls under his hand on a sand-stone; marble is too smooth for this purpose. Lads who are used to it can turn 8 or 10 under each hand at one time. When finished, put into powdered sugar, wrap in fancy papers fringed at the ends, put a motto in each, and fasten with small bands of gold paper. Sometimes a cracker is folded up in each; this is made with two narrow strips of stiff paper, a small piece of sand or glass paper pasted on the end of each, these are placed over each other with a little fulminating powder between, a piece of thin paper is bound round it, and pasted to keep them together; when these are pulled asunder, the two rough surfaces meeting cause the powder to explode, and out flies the ball of sugar with the motto.

Brandy Balls.—These are made from loaf sugar, boiled to crack, coloured with either cochineal or saffron, and finished the same as acidulated drops without being flattened.

Clove, Ginger, or Peppermint Rock.—These are all made in the same way as raspberry, using the essential oil of each for flavour. For clove, the mixture, whilst boiling, is coloured with cochineal; ginger, with saffron; but the peppermint must be kept perfectly white, except the stripes, which is done by cutting off as many pieces from the bulk as you have colours, which should be in powder; put a sufficiency in each piece to give the desired tint, and keep warm. When the remaining portion of the sugar is pulled, lay them over the surface in narrow stripes, double the roll together, and the face each way will be alike. Pull out into long sticks, and twist; make round by rolling under the hand; or cut into small pieces with a pair of shears or scissors, for pellets, pincushions, &c.

Extracting the Acid from Candied Drops, &c.—Articles which have acid mixed with them are extremely liable to grain, when they are useless except to sell for broken pieces, as they cannot be boiled again unless the acid is extracted. The method of doing this is only returning to the first principle in the manufacture of sugar. When the juice is expressed from the sugar-canes, it contains a considerable quantity of acid, which must be destroyed before it will granulate into sugar; for this purpose, lime is employed, and has the desired effect; it will also in this case, but chalk or whiting is most generally used. First dissolve your acid sugar in water; when this is thoroughly accomplished, mix in a sufficient quantity of either of these alkaline powders to cause a strong effervescence; after it has subsided, pass through a flannel bag, according to the directions for clarifying sugar. The filtered syrup will be fit to use for any purpose, and may be boiled again to crack or caramel as well as if no acid had ever been mixed with it. Let the pan it is dissolved in be capable of containing as much again as there is in it.

Nogat.—Take 2 lb. of sweet almonds, 1 lb. sugar. Blanch the almonds, cut in slices, dry at the mouth of a cool oven and slightly brown; powder the sugar, and put it into a stewpan, without water; place on the fire to melt, stirring with a spatula, until it becomes a fine brown; then mix in the almonds, and let them be well covered with the sugar; pour out on an oiled marble stone. It may be made into a thick or thin sheet, and cut with a knife into small pieces, such as dice, diamonds, &c. The surface may be strewed with currants, fillets of pistachios, or coarse sugar, and cut into different forms with tin cutters; it may also be formed into baskets, vases, &c. Oil the interior of a mould, and spread the nogat over, whilst warm, as thin and even as possible. To save the fingers from being burnt, it may be spread with a lemon. Detach from the mould when warm, and let remain until cold, that it may retain its shape perfectly, then fasten the different parts together with caramel sugar. For baskets, a handle of spun sugar may be placed over or ornamented with it. These may be filled with whipped or other creams when required to be served.

Raspberry Rock or Sticks.—This may be made from raw or refined sugar. Boil to crack, and colour with cochineal; pour it on a stone rubbed with a little oil or butter; cut off a small piece, and keep warm to stripe or case the other part, when finished; to the remainder add a little tartaric acid (not so much as for drops), and some raspberry-paste to flavour it. The residue of raspberries used for making vinegar, and preserved with an equal quantity of sugar, or even less, as for raspberry cakes, does very well for this purpose. Fold the edges over into the centre, and attach to a hook fixed against the wall; pull towards you, throwing it on the hook each time after having pulled out; continue until it gets white and shining; then make into a compact long roll, and either stripe with the piece cut off, or roll in a sheet with a rolling-pin, and wrap round so as to form a sort of case; then pull into long narrow sticks, and cut the required length.

Spinning.—Proficiency in this requires much practice, a good taste for design, and expertness in boiling, taking particular care to avoid graining. The moulds may be made either of copper or tin, slightly rubbed over with butter or oil. Boil clarified syrup to "caramel," taking care to keep the sides of the pan free from sugar. The moment it is at crack, add a little acid to "grease" it. When at caramel, dip the bottom of the pan into cold water, take out, and let cool a little; then dip a tablespoon in the sugar, holding the mould in your left hand, and from the spoon run the sugar over the mould, either inside or out, with the threads which flow from it, which may be either fine or coarse, according to the state of the sugar. If required very coarse, pass the hand over them 2 or 3 times; when hot, it flows in finer strings than when cooler. Form on the mould into a sort of trellis-work; loosen from the mould carefully, and let remain until quite cold before taking off, that it may retain its shape. When the sugar gets too cold to flow, put it beside the stove or fire.

Acid Drops.—These are best made with loaf sugar. To 10 lb. put ½ oz. cream of tartar with the water, and boil to crack. Pour on the stone, and work in 2½ oz. finely powdered tartaric acid. Instead of making into drops by hand, this is now done by a machine, called a "drop machine." The rollers are either slightly oiled before a thin sheet of the sugar is passed through them, or the sheet of sugar itself is dusted with finely powdered sugar. In large establishments, all kinds of drops, balls and sticks are made by machine.

Raspberry Drops are made as acid drops, with the addition of orris powder, and the sugar is coloured red in the boiling with prepared cochineal.

Almond Baskets.—Blanch some fine Jordan almonds, cut into thin slices, and colour in a small copper pan over the fire with prepared liquid colour. Put into pan, and pour in colour sufficient to give desired tint; rub about in the pan with your hand until quite dry; form as for a Chantilly basket, and spin sugar over, or form on an oiled marble slab, and spin sugar over on each side. Afterwards arrange in a mould, or build to any design, first having a pattern cut out in paper, and form on the stone from it.

Chantilly Baskets. — Prepare some ratafias rather small, and near of a size; boil some sugar to "caramel," rub the inside of a mould slightly with oil, dip the edge of the ratafias in sugar, and stick them together, face towards the mould, except the last two rows on the top, which should be reversed, their faces meeting the eye when the sugar is cold; take out, and join the bottom and top together with the same sugar; make a handle of spun sugar, and place over. Sugar may be spun over the inside of the basket, to strengthen it, as directed for webs. Line the inside with pieces of Savoy or sponge cake, and fill with custard or whipped cream, or the slices of cake may be spread with raspberry jam. Half fill with boiled custard, put in a few Savoy or almond cakes soaked in wine, and cover the top with whipped cream; or fill with fancy pastry, or meringues. All sorts of fancy cakes may be made into baskets as ratafias.

Gold Web.—Boil syrup to caramel, colouring with saffron, and form as directed for silver. It can be folded up to form bands or rings. Fasten to other decorations with caramel. If a string or thread of sugar should pass over parts where they are not required, so as to spoil the other decorations in the making of baskets or other ornaments, it may be removed with a hot knife without breaking or injuring the piece.

Grape, Orange, or Cherry Baskets.—Similar to Chantilly. The oranges are carefully peeled and divided into small pieces, taking off the pith. Insert a small stick or whisk in the end of each, dip in caramel, and form on the inside of an oiled mould. Cherries and grapes may be used fresh, or preserved wet, and dried. Dip in caramel, and form as oranges. Each after being dipped in caramel, may be laid on an oiled marble slab separately, and served on plates in a pyramid, with fancy papers, flowers, &c. The baskets are finished as Chantilly with spun sugar.

Raspberry Rock.—In this, orris powder, with a little tartaric acid, is frequently used as a substitute for raspberry paste, in the same manner.

Rock Sugar.—Boil 1 qt. clarified syrup to crack. Have some icing previously prepared as for cakes, or mix some fine powdered loaf sugar with white of egg to a thick consistency, as for icing; take the sugar from the fire, and as soon as the boiling has gone down stir in a spoonful of this or the icing, which must be done very quickly, without stopping. Let rise once and fall; the second time it rises, pour out in a mould or paper case, and cover with the pan to prevent falling. Some pour it out the first time, and immediately cover. It may be made good both ways. If required coloured, add colouring to the syrup whilst boiling, or with the icing, adding more sugar to give the same stiffness as before. For vases or baskets, prepare some plaster moulds, as for grained sugar; soak in water before use; prepare some sugar and fill the moulds. When finished, they may be ornamented with gum-paste, piping, or gold-paper borders. Fill with flowers, meringues, fancy pastry, caramel fruits, &c. They may be made in copper or tin moulds, by oiling before they are filled.

Silver Web.—Boil clarified syrup to crack, using the same precautions as before, giving a few boils after the acid is added; dip the bottom of the pan in water, and let the sugar cool a little; then take the handle of a spoon, or two forks tied together, dip into the sugar, and form either on the inside or outside of a mould, with very fine strings, by passing the hand quickly backwards and forwards, taking care that it does not fall in drops, which would spoil the appearance of the work. Take a fork or iron skewer, and hold in your left hand as high as you can, dip the spoon in the sugar, and with the right hand throw it over the skewer, when it will hang from it in very fine threads of considerable length.

Drops.—Take treble-refined sugar with a good grain, pound, and pass through a coarse hair sieve; sift again in a lawn sieve, as the sugar, when too fine, makes the drops compact, and destroys their brilliancy. Put some of the coarse sugar into a small drop pan (with a lip on the right side, so that when held in the left hand the drops may be detached from it with the right), moisten with any aromatic spirit, and sufficient water to make it of a consistence just to drop off the spoon or spatula without sticking to it. Colour with any colour ground fine and moistened with a little water. Place the pan on the stove fire, on a ring of the same size. Stir occasionally until it makes a noise, when it is near boiling: do not let it boil; take from the fire and stir well with the spatula until of the consistence that when dropped it will not spread too much, but retain a round form on the surface. If too thin, add a little of the coarse sugar, reserved for the purpose, and made of the thickness required. Have very smooth plates, of tin or copper, quite clean; drop on these, separating the sugar from the lip of the pan with a piece of straight wire, as regularly as possible. About 2 hours afterwards they may be taken off with a thin knife. If you have no plates, drop on smooth cartridge paper. Wet the back of the paper to take them off. Cover the bottom of a sieve with paper, lay them on, and put in the stove for a few hours, but not long enough to deprive them of their fragrance.

Catechu.—1 lb. sugar, 3 oz. catechu. Make as violet. May also add musk or ambergris—about 15 gr.

Chocolate.—1 lb. sugar, 1 oz. chocolate. Scrape the chocolate to powder, mix with the sugar in coarse grains, moisten with clean water, and proceed; do not mix more than can be dropped out whilst warm at one time. If any remains in the pot, it will grease the next, and will not attain the consistence required.

Cinnamon.—1 oz. cinnamon, 1 lb. sugar. Pulverize the cinnamon, and sift through a lawn sieve. Mix with the sugar, and add 2 or 3 drops of the essential oil if the flavour is not strong enough. Moisten with water and proceed. The flavour may be given with essential oil only, colouring with bole ammoniac.

Clove.—As cinnamon.

Coffee.—1 oz. coffee, 1 lb. sugar. Make a strong clear infusion of coffee, as for coffee ice, and use to moisten the sugar. Make the drops as chocolate.

Ginger.—Mix sufficient best powdered ginger to give the desired taste, or flavour with essence of ginger, and colour with saffron. Moisten with water, and make as others.

Lemon.—Rub the yellow rind of lemons on a piece of rough sugar, scrape off, and mix with the coarse sugar. Use sufficient to give a good flavour, and colour with saffron; moisten with water, as others.

Orange-flower.—Use orange-flower water to moisten the sugar, or flavour with essence of neroli and moisten with water.

Orgeat.—Make milk of almonds, using a little orange-flower water; moisten the sugar with it.

Peppermint.—Moisten the sugar with peppermint water, or flavour with essence of peppermint, and moisten with water.

Raspberry.—Press the juice of ripe raspberries through a piece of flannel, and moisten the sugar with it.

Rose.—Moisten the sugar with rose water, and colour with cochineal.

Vanilla.—As cinnamon, using a little sugar to pound the vanilla; or may be moistened with essence of vanilla, but this greases it as chocolate.

Violet.—1 lb. sugar, 1 oz. orris powder; moisten, and colour violet.

All fruit drops are made with expressed juice, except orange. When you first rub the rind of the fruit on sugar, squeeze the pulp of the fruit, and pass through a hair sieve. Scrape off the sugar on which the rind was rubbed, mix with sufficient pulp to give the desired flavour, and moisten with water. These grease the sugar, and require the same precautions as chocolate drops.

Ices.—*Apparatus.*—(1) Pewter pots of various sizes, suitable to the quantity of mixture to be frozen. Tin or zinc will not do, as they congeal the mixture without allowing it time to become properly incorporated, and form it in lumps like hailstones. (2) ½ pint, pint, 1½ pint, and quart pewter moulds, and some in the form of fruits to open in the centre with a hinge. (3) Ice pails, adapted to the size of the pots, about the same depth, and 8 or 10 in. more in diameter; if even greater, it is immaterial, the depth being the principal consideration; the deeper it is, the greater caution is required to prevent the salt from entering the mixture, for as the ice dissolves, the pot descends, and the water runs under the cover, which, being salt, spoils the contents. There should be a hole near the bottom, with a cork fitted in, to be withdrawn at pleasure, that the water may be run off when there is too much. (4) The spatula is an instrument somewhat resembling a gardener's spade, made of stout tinned copper, the blade about 4 in. long by 3 in width, round at the end, and having a socket to receive a wooden handle; it is for scraping the cream from the sides of the pot as it freezes, and for mixing. (5) A large mortar and pestle, or a strong box and mallet for pounding the ice. (6) A spade to mix the ice and salt, fill pails, &c. (7) A tin case with a drawer to be drawn out at pleasure, and having shelves or divisions for keeping ices in the form of fruits, after they are finished, until required.

Freezing is accomplished by means of various mixtures. As a general rule, take about 2 lb. salt to every 6 lb. ice. The more salt mixed with the ice, the quicker are the creams frozen. Pound sufficient ice small, and well mix some salt with it; place the pot containing the mixture in a pail, fill the latter with pounded ice and salt as far as the lid; strew a handful of salt on the top of the ice, let remain a few minutes until you have similarly disposed of others, as 3 or 4 may be done at a time, whirl round briskly by means of the handles for 5 minutes, take off the lids one at a time, and with the spatula stir or carry the unfrozen part well round the sides, turning the pot also with the left hand; continue this for 2 or 3 minutes, which serves to soften what has already frozen, as well as helps to freeze the remaining portion; then scrape from the sides, put on the lids, whirl round again briskly as before directed, repeating the same operations every 4 or 5 minutes. As it forms, do not spare labour in working or mixing it together when you scrape it down, so as to make it perfectly smooth and free from lumps, for the smoothness depends on this operation; continue to freeze until the whole is well set. Ice well frozen should be about the consistence of butter, tough to the feel, of a good colour, and without any lumps in it. Those containing too much syrup cannot be frozen to the degree required, and those with too little freeze hard, and feel short and crisp like compressed or frozen snow, which arises from having too many watery particles, by the excess of water or milk. It may be ascertained when freezing commences, by the first coat which is formed round the sides. It should then be altered by either adding more cream or water, with juice or pulp of fruit, or other flavouring matter, in proportion, as the case may be, if too rich, and *vice versâ*, by the addition of more syrup, &c., when poor; but at all times the necessity of altering should be avoided, as the component parts cannot be so perfectly blended without considerable extra labour, as if they were properly mixed at the commencement. During the freezing, or after the creams are moulded and set up, if there is too much water in the pail, the frigorific power is lessened; a little increases it, as at first it is only a solution of the salt; but as the ice dissolves and mixes with it, it decreases; therefore, when it comes to the top, drain the water off, and fill up with fresh salt and ice. When the ices are properly frozen, take out the pots, drain off the water, empty the pail; again replace and fill with fresh salt and ice as before, spread the creams over the sides of the pot, when they are ready for use, if intended to be served in a shop, or by glassfuls. For moulds, line the bottom with a piece of paper before you put it on; if there is no impression or figure on the top, you may cover that also with paper; in filling, press well in, so as to fill every part; leave a little projecting above the surface to form the top, which you put on; pack the moulds in a pail, and fill the vacancies with pounded ice well mixed with plenty of salt; strew a handful also on the top. Ices should be moulded ½ to 1 hour before they are served. To turn them out, wash the mould well in cold water that no salt may remain on; take off the bottom and top, and the ice will come out easily. For fruit moulds, fill each with cream or water ice of the same kind as you would represent, and preserve the stone with the stalk and leaves of each, which put in their proper places, allowing the leaves to project outside; close the mould, wrap in paper, and place in ice as others; to turn out, wash the shape in lukewarm water to take off the paper, and be careful not to injure the leaves, as they will often be found frozen to it; dip again in water, open and take out the ice; colour to nature with camel's-hair pencils and liquid colour; the down or bloom is represented by dusting with dry colour powder tied in a small muslin bag, or by means of a dry camel's-hair pencil; line the shelves of the case with paper or vine leaves, and put in the fruit as it is finished; let the case be surrounded with pounded ice and salt, as for moulds.

Ices are of 3 classes, viz.: cream, custard, and water. These derive their names from the bases of which they are composed, the flavouring matter giving a second definition thus, "raspberry cream" and "raspberry water"; but custard ices are not so particularly defined as the others by the bases, and only receive the name of the flavour.

Almond or Orgeat Ice Cream.—1 qt. cream, 8 oz. sweet almonds, 2 oz. bitter almonds, 12 oz. sugar, 2 oz. orange flower water; blanch the almonds, and pound quite fine in a mortar, using the orange-flower water to prevent their oiling; rub through a sieve, and pound again the portion which has not passed through, until fine enough; mix with the cream, and make into a custard with 7 yolks of eggs; strain, and when cold, freeze.

Apple Water Ice.—Pare and core some fine apples, cut in pieces into a preserving pan with sufficient water for them to float, boil until reduced to a marmalade, strain; to 1 pint apple-water add ½ pint syrup, juice of a lemon, and a little water; when cold freeze.

Apricot—(1) Fresh Fruit.—24 fine ripe apricots, 1 qt. cream, 12 oz. sugar, the juice of 2 lemons, with a few of the kernels blanched; mash the apricots, rub through a sieve, mix, and freeze.

(2) From Jam.—12 oz. jam, 1 qt. cream, the juice of 2 lemons, 8 oz. sugar, a few kernels or bitter almonds blanched and pounded fine; rub the whole through a sieve, and freeze.

Apricot Water Ice.—18 or 20 fine ripe apricots, ½ pint syrup, ½ pint water, juice of 2 lemons. Mash the apricots, pass through a sieve, mix the pulp with the syrup, water and lemon-juice, break the stones, blanch the kernels, pound fine with a little water, pass through a sieve, add to the mixture, and freeze.

Barberry.—Same proportions as currants (1). Soften fresh barberries by boiling in the syrup you intend to use, or put in a stewpan, and stir over the fire until tender; pass through a sieve, mix, and freeze as raspberry. Barberries require no lemon-juice.

Biscuit Cream.—Crumble some Savoy biscuits and a few ratafias, add the rind of 2 lemons rubbed on sugar, and mix with the cream when frozen.

Brown Bread Ice.—Make 1 qt. custard for ice, crumble a piece of brown bread quite fine, put on a tin, and dry just inside the mouth of the oven, or in a very hot stove; freeze the cream, and when the bread is cold, work or stir it in.

Burnt Almond Ice Cream.—As filbert (2).

Burnt Ice Cream.—To 1 qt. custard for ice put into a stewpan 4 oz. powdered sugar; place by the side of the stove, or over the fire to melt and burn fine brown, stirring constantly; when the proper colour, mix the custard quickly with it; when cold, freeze.

Cherry Ice Cream.—2 lb. cherries, 1 qt. cream, 12 oz. sugar or syrup; pound the cherries, with the stones, in a mortar, adding a few ripe gooseberries or currants, pass the pulp through a sieve, add the cream and sugar, juice of 2 lemons and a little cochineal, mix and freeze. From preserved fruit it is made the same way, adding a little noyau, or a few bitter almonds pounded for the flavour of the kernel.

Cherry Water Ice.—2 lb. cherries (Kentish or May-Duke), 4 oz. ripe gooseberries, 1 pint syrup, ½ pint water, juice of 2 lemons; pound the cherries with the stones in a mortar, pass the juice of the fruit through a sieve, mix the syrup and water with it, and freeze; if it should not freeze sufficiently, add a little more water.

Chestnut Ice.—As filbert, taking off husks and skin.

Chocolate Ice.—1 qt. cream, 6 oz. chocolate, 10 oz. sugar; dissolve the chocolate in a little water, or make the sugar into a syrup; add the cream and eggs, and make into a custard; when cold freeze.

Coffee Ice Cream.—(1) 1 qt. cream, 5 oz. Mocha coffee, 12 oz. sugar; roast the coffee in a coarse iron or other stewpan, keeping constantly stirred until a good brown colour, throw into the custard cream whilst quite hot, and cover closely; let it infuse for an hour or two, then strain and freeze. (2) With an infusion of coffee, thus: take the quantity of coffee, freshly roasted and ground to fine powder; put into a glass bottle, and pour on sufficient cold river water to moisten the powder and make an infusion; stop the bottle close and let remain all night; next day, filter the infusion by passing through fine lawn or blotting paper placed in a glass funnel; by this process a very strong and superior infusion is obtained, which contains all the aroma of the coffee. Use for flavouring the custard, and freeze.

Cream.—Cream ices are composed of cream, or ¾ cream and ¼ milk, with the juice or pulp of fresh or preserved fruit, and syrup or sugar so blended that the taste of one may not predominate over another; but if either is in excess, it should be the fruit.

Currant.—(1) From fresh fruit. 1½ pint ripe currants, ½ pint raspberries, 1 qt. cream, the juice of 2 lemons, and 12 oz. sugar. Mix as raspberry. (2) Preserved fruit. The same proportions as raspberry, using either jam or jelly.

Currant Water Ice.—2 lb. ripe currants, 8 oz. raspberries and ripe cherries, 1 pint syrup, the juice of 2 lemons and 1 pint water. Pick and mash the fruit, strain through a sieve, add the syrup and water, put in the ice-pot, and freeze.

Custard for Ices.—1 qt. cream, 6 eggs, 12 oz. powdered loaf sugar. break the eggs into a stewpan, and whisk together; add the cream and sugar; when well mixed, place on the fire, and continue stirring from the bottom with the whisk, to prevent burning, until it gets thick; take from the fire, continue to stir for a few minutes, and pass through a sieve. If the custard be suffered to boil, it will curdle.

Custard Ices.—These resemble cream ices, with the addition of 6 eggs to each qt. of cream, or 8 if part milk is used. All kinds of nuts, liqueurs, essences, infusions, or biscuits, are principally mixed with it.

Damson Ice.—1 qt. damsons, 1 pint syrup, ½ pint water. Mix as peach ice. Magnum bonums, Orleans, greengages, or any other plum may be done in the same way.

Filbert Ice Cream.—(1) 1 qt. cream, 1 lb. nuts, 12 oz. sugar or 1 pint syrup; break the nuts, roast the kernels in the oven; pound with a little cream, make a custard, and finish as almond ice. (2) Burnt. Same proportions; put the kernels into the syrup, boil until they crack; stir the sugar with a spatula, that it may grain and adhere to the nuts; when cold, pound with the sugar quite fine; make a custard and mix them with it, allowing for the sugar that is used for the nuts; mix and freeze as the others.

Ginger.—6 oz. preserved ginger, 1 qt. cream, ½ pint of the syrup from the ginger, sufficient sugar to sweeten with, juice of 2 lemons; pound the ginger in a mortar, add the cream, and freeze.

Gooseberry Water Ice.—2 lb. ripe gooseberries (red hairy sort), 1 lb. cherries, 1 pint syrup, 1 pint water, juice of 2 lemons; mash the fruit, pass through a sieve, mix with the syrup and water, and freeze.

Lemon Ice Cream.—6 large lemons, 1 qt. cream, and 12 oz. sugar, or ½ pint syrup; grate the peels of 3 lemons into a basin, squeeze the juice to it, let stand for 2 or 3 hours, strain, add the cream and syrup, and freeze or mix as orange.

Lemon Water Ice.—½ pint lemon-juice, ½ pint water, 1 pint syrup, peels of 4 lemons rubbed on sugar (or the yellow rind pared or grated off, and the juice squeezed to it in a basin), let remain for an hour or two, strain, mix, and freeze; whip the whites of 3 eggs to a strong froth, with a little sugar, as for meringues; when the ice is beginning to set, work well in; freeze to required consistence; if to be served in glasses, the meringue may be added after it has been frozen.

Liqueur Cream Ice.—(1) As noyau, flavour with the different liqueurs from which each is named. (2) Put 1 qt. cream into the ice-pot with 6 oz. sugar, which place in the ice; work well about the sides with a whisk for 5 minutes; add a glassful of liqueur, work together; whisk the whites of 2 eggs to a strong froth, add 2 oz. sugar, mix well with the cream, and freeze to the required consistence.

Liqueur Water Ice.—Lemon ice, using less water, and making up the deficiency with liqueur; if the taste of the lemon prevails too much, add more water and syrup to correct.

Mille Fruit Ice Cream.—Flavour a lemon cream ice with elder flowers, mix in some preserved dried fruits and peels cut in small pieces. Before it is moulded, sprinkle with prepared cochineal, and mix a little, that it may appear marbled.

Mille Fruit Water Ice.—Make a good lemon ice, with 1 pint syrup, ½ pint water, and as much strained lemon-juice as will give the desired flavour, with some elder flowers infused in syrup; when frozen, add some preserved green fruits and peels cut into small dice; sprinkle with prepared cochineal, and mix in a little to give a veined appearance.

Noyau Cream Ice.—Custard cream, and flavour with noyau; finish as almond ice.

Orange Ice Cream.—(1) 6 Seville oranges, 3 lemons, 1 qt. cream, 12 oz. sugar or syrup; rub the yellow rind of 2 or 3 of the oranges on part of the sugar, scrape off with a knife, squeeze out the juice of the oranges and lemons, and strain; mix with the cream and the sugar on which the rind was rubbed, add the other part of the sugar, dissolve, and freeze. (2) 8 China oranges, 2 lemons, 1 qt. cream, 12 oz. sugar; rub the rind of 4 or 5 of the oranges and 1 lemon on sugar, squeeze, strain the juice; add the cream, mix, and freeze.

Orange Water Ice.—1 pint China orange juice, 1 pint syrup, ½ pint water, juice of 4 large lemons. Rub the yellow rind of 4 oranges and 2 lemons on sugar, scrape off, and mix with the strained juice, syrup, and water.

Peach.—As apricot.

Peach Water Ice.—1 lb. pulp of ripe peaches, ½ pint syrup, ½ pint water, juice of 2 lemons. Mix as apricot. If the fruit is not ripe enough to pulp, open and take out the stones, put in a stewpan with the syrup and water, boil until tender, and pass through a sieve; mix in the pounded kernels; when cold, freeze.

Pear Water Ice.—As apple.

Pine-apple—(1) Fresh Fruit—1 lb. fresh pine-apple, ½ pint syrup in which a pine has been preserved, 2 or 3 slices pine-apple cut in small dice, juice of 3 lemons; pound or grate the pine-apple, pass through a sieve, mix with 1 qt. cream, and freeze. (2) Preserved fruit—8 oz. preserved pine apple, 1 qt. cream, juice of 3 lemons, sufficient pine syrup to sweeten it: pound the preserved pine, mix lemons with the cream, and freeze.

Pine-apple Water Ice.—(1) ½ pint pine syrup, 1 pint water, juice of 2 lemons, 3 or 4 slices preserved pine cut into small dice; mix and freeze. (2) Fresh.—1 lb. pine-apple, 1 pint syrup, ½ pint water, juice of 2 lemons. Cut the pine in pieces, put into a stewpan with the syrup and water, and boil until tender; pass through a sieve, add the lemon-juice with 2 or 3 slices of the pine cut in small dice, mix, and when cold freeze.

Pistachio Ice Cream.—1 qt. cream, 8 oz. pistachios, 12 oz. sugar; blanch and pound the pistachios with a little of the cream; mix and finish as orgeat, flavouring with essence of cédrat, or the rind of a fresh citron rubbed on sugar; or the custard may be flavoured by boiling in it a little cinnamon and mace and the rind of a lemon; colour with spinach.

Punch Water Ice.—Make a good lemon ice, or use some orange juice with the lemons, in the proportion of 1 orange to 2 lemons; either rub off the yellow rind of the lemons on sugar, or pare it very thin, and soak it in the spirit for a few hours; when the ice is beginning to set, work in the whites of 3 eggs to each qt., beaten to a strong froth, and mixed with sugar as for meringue, or add the whites without whisking; when nearly frozen, take the pot from the ice, and mix well with it some rum and brandy (the prevailing flavour distinguishes it as rum-punch or brandy-punch ice); after the spirit is well mixed, replace the pot and finish freezing. Champagne, arrack, or tea may be added.

Raspberry.—(1) Fresh fruit. 1 qt. raspberries, 1 qt. cream, ¾ to 1 lb. sugar; a few ripe currants and gooseberries or cherries may be added, instead of all raspberries, and the juice of 2 lemons; mash the fruit, pass through a sieve to take out the skins and seeds, mix with the other articles, add a little prepared cochineal to heighten the colour, put it in the pot, and freeze. All ices made with red fruit require this addition of cochineal. (2) Jam. 1 lb. jam, 1 qt. cream, about 6 oz. sugar or syrup, and the juice of 2 lemons. Mix as before.

Raspberry Water Ice.—1 qt. ripe raspberries, 4 oz. ripe cherries and currants, ½ pint syrup, ½ pint water, juice of 2 lemons. Mash the fruit, pass the juice through a sieve, mix the syrup water and lemon with it, and freeze.

Ratafia Cream.—1 qt. cream, as for brown bread, 6 or 8 oz. ratafia cakes crumbled quite fine; mix with the cream when frozen.

Roman Punch Ice.—Make 1 qt. lemon ice, and flavour with rum, brandy, champagne, and Maraschino; when frozen, to each quart take the whites of 3 eggs, and whip to a very strong froth; boil ½ lb. sugar to the ball, and rub it with a spoon or spatula against the sides to grain it; when it turns white, mix quickly with the white of egg, stir lightly together, when cold add it to the ice; mix well together, and serve in glasses; less sugar must be used in the ice, so as to allow for that which is used in making the meringue.

Strawberry.—As raspberry.

Strawberry Water Ice.—2 pottles best scarlet pines, 1 pint syrup, ½ pint water, juice of 2 lemons. Mix as currant. All red fruits require a little prepared cochineal to heighten the colour.

Swiss Pudding.—Take 1½ pint cream, and ½ pint milk, and make into a custard with 7 yolks of eggs; flavour with Curaçoa, Maraschino, or rum; freeze the custard, and add about ¼ lb. dried cherries, orange, lemon, and citron peel, and currants; mix in the iced custard. The Curaçoa or rum may be poured over the fruit when you commence freezing, or before. Prepare the mould, which is melon shaped, opening in the centre with a hinge. Strew over the inside with clean currants, fill and close; immerse in some fresh ice mixed with salt. Before turning out, prepare a dish as follows:—Make a little custard, and flavour with brandy; dissolve some isinglass in water or milk, and when nearly cold add sufficient to the custard to set it; pour into the dish you intend to serve on. As soon as set, turn the pudding on it, and serve.

Tea Ice.—1 qt. cream, 2 oz. best green tea, 12 oz. sugar; put the tea into a cup, pour on a little cold river water in which has been dissolved a portion of carbonate of soda (about as much as may be placed on a fourpenny piece), let remain for an hour or two, add boiling water sufficient to make a very strong infusion; or cold water in proportion, letting it soak longer, when a superior infusion will be obtained; strain, and add to the cream and eggs. Finish as the others.

Vanilla Ice.—1 qt. cream, ½ oz. vanilla, 12 oz. sugar; cut the vanilla into small pieces, and pound with the sugar until quite fine; add to the cream and eggs, make into a custard, strain, and when cold freeze.

Lozenges.—Lozenges are compounded of finely powdered loaf sugar and other substances (liquid or powdered), held together in a paste by means of gum solution, then rolled into thin sheets, and stamped into little cakes. The chief precaution necessary is to have the gum of sufficient tenacity. Some gum solutions used are: (1) 1 oz. tragacanth, ½ pint water; soak in a warm place for 24 hours; put into a coarse cloth, and twist until all the gum has been squeezed out; 1 oz. of this dissolved gum suffices for 4 to 5 lb. sugar. (2) 1 oz. dissolved gum arabic to 12 oz. sugar. (3) 1 oz. tragacanth and 3 oz. gum arabic. (4) 1 lb. gum arabic dissolved in 1 pint water, for all but "medicinal" lozenges. (5) 2½ lb. gum arabic dissolved in 1 qt. water, and 1 oz. tragacanth in ½ pint water, for all lozenges.

Bath Pipe.—(1) 8 lb. sugar, 12 oz. liquorice. Warm the liquorice, cut in thin slices, dissolve in 1 qt. boiling water, stir well to assist the solution; let settle, when dissolved, to allow impurities to fall down; pour off free from the sediment; dissolve the gum in the clear part, and mix into a paste as for lozenges. Roll out a piece with your hand in a round form; finish rolling it with a long flat piece of wood, until it is about the size of the largest end of the stem of a tobacco-pipe. Dry in the stove as lozenges. May be flavoured with aniseed by adding a few drops of the oil, or with catechu or violets by adding orris-root or catechu powders. Any paste for lozenges may be formed into pipes by rolling it out as for Bath pipes. They are occasionally striped blue, green, and yellow, by making strips with liquid colour on the paste and twisting before rolling out with the board.

(2) 10 oz. powdered gum arabic, 13 oz. Spanish juice, 13½ lb. lawned sugar, 1 oz. tartaric acid. Dissolve the liquorice; strain, evaporate to a thick consistence, and keep covered with a damp cloth to prevent drying. When cold, work in the sugar, acid, and gum, as for lozenges, and make into pipes.

Brilliants.—Take either of the pastes (1) to (4) for peppermint lozenges, and cut into small fancy devices.

Catechu.—(1) 4 lb. sugar, 12 oz. catechu. Make into paste with dissolved gum. (2) A l'Ambergis. To paste for (1), add 16 gr. ambergris. (3) With Musk. Same as for (1), adding 16 gr. musk. (4) With Orange-flowers. As before, adding 12 drops essence of neroli. (5) With Violets. As before, adding 3 dr. Florence orris-root powder.

Cinnamon.—2 oz. dissolved tragacanth, 8 lb. lawned sugar, 1 oz. powdered cinnamon, 10 drops essential oil. Mix into a paste, and colour with bole ammoniac. Stomachic.

Clove.—8 lb. sugar, 3 oz. cloves, 2 oz. tragacanth. Each should contain 2 gr. cloves. Restorative and stomachic.

Colt's-foot Rock.—1 lb. Spanish liquorice dissolved in ¾ pint water; 2 oz. tragacanth dissolved in 1¼ pint water; 28 lb. lawned sugar, 1 oz. essence of lemon, 2 oz. extract of poppies. Colour with Spanish brown. Make into a paste. Force through a metal tube with a plate at the bottom, having holes at the bottom similar to a star, by the means of a screw. Cut into lengths, and dry.

Ementine.—1 lb. sugar, 5 dr. ementine, sufficient dissolved gum to make a paste; colour with carmine, and make 1300 lozenges. (2) Pure.—1 lb. sugar, 24 gr. pure ementine, sufficient gum to make paste. Makes 1040 lozenges.

Ginger.—8 lb. sugar and 8 oz. best ground ginger. Mix into a paste with dissolved gum. Essence may be used instead of powder, colouring with saffron. Stimulant and stomachic.

Ipecacuanha.—4 lb. sugar, 1 oz. ipecacuanha, sufficient dissolved gum to make a paste. Make 960 lozenges, each containing ½ gr. ipecacuanha. Expectorant and stomachic.

Lavender.—As rose lozenges, using English oil of lavender instead of rose.

Magnesia.—(1) 8 oz. calcined magnesia, 4 oz. sugar, 2 scr. ginger powder, sufficient dissolved gum arabic to form a paste. (2) 2 oz. magnesia, 8 oz. sugar, sufficient gum arabic to make a paste, dissolved in orange-flower water.

Marshmallow.—1 lb. marshmallow root powder or slices, make a strong decoction, in which dissolve the gum; 4 lb. fine sugar. Mix into a paste. 6 drops laudanum and 2 oz. liquorice improve the pectoral quality.

Nitre.—4 lb. sugar, 1 lb. salnitre, sufficient dissolved gum tragacanth to make a paste.

Nutmeg.—8 lb. sugar, 1 oz. oil of nutmegs, sufficient dissolved gum to mix into a paste. Stimulant and stomachic.

Patta Rosa.—Rose lozenges, with the addition of a little tartaric acid.

Peppermint.—(1) Double-refined loaf sugar, pounded and sifted through a lawn sieve; make a bay with the sugar on a marble slab, pour in some dissolved gum, and mix into a paste as dough, flavouring with oil of peppermint. Some prefer mixing the gum and sugar together first in a mortar Roll out the paste on a marble slab until it is about ⅛ in. thick, using starch powder to dust with, to prevent sticking to the slab and pin. Before cutting out, strew or dust over the surface with powder mixed with lawned sugar, and rub over with the heel of your hand, which gives a smooth face. This is termed "facing up." Brush off, and again dust the surface with starch powder, cut out, and place in wooden trays. Put in the stove to dry. All lozenges are finished in the same manner. (2) As (1), adding a little starch-powder or prepared plaster as for gum paste to the paste, instead of using all sugar. (3) Use more starch powder in proportion; smaller cutters, and the paste rolled thicker. (4) Transparent. These are made from loaf-sugar in coarse powder; mix into a paste with dissolved gum arabic and a little lemon-juice. Flavour with oil of peppermint. (5) Superfine Transparent. The sugar must be in coarser grains. Mix and flavour as the others. The coarser the grains of sugar, the more transparent the lozenges. The finest particles destroy transparency. The solution of gum should be thicker in proportion as the sugar is coarse.

(6) The commonest peppermint lozenges are made with half farina (prepared starch), and half loaf-sugar, of second quality. A little smalt blue is added to make them of a good colour.

Refined Liquorice.—4 lb. best Spanish juice, and 2 lb. of gum arabic. Dissolve the liquorice in warm water, as for Bath pipe. Strain, and dissolve the gum in the solution of liquorice. Place over a gentle fire, in a broad pan, and let boil gradually, stirring continually (or it will burn) until reduced to a paste. Roll into pipes or cylinders of convenient lengths, and polish by putting in a box and rolling together, or by rubbing with the hand or a cloth. Often adulterated by using glue instead of gum, and by dipping the pipes in a thin solution, which gives them a beautiful gloss when dry. In manufacture on a large scale, the liquorice is dissolved in a large water-bath, and stirred with spatulas worked by a steam-engine.

Rhubarb.—4 lb. sugar, 10 oz. best Turkey rhubarb in powder.

Rose.—Make paste as peppermint (1), using otto of roses to flavour; or the gum may be dissolved in rose water, and a little essential oil added if required. Colour with carmine.

Saffron.—4 oz. dry and powdered saffron, 4 lb. sugar, sufficient dissolved gum.

Sponge.—1 lb. sugar, 12 oz. burnt sponge, sufficient gum arabic dissolved in rose water to make into a paste.

Steel.—1 lb. pure iron filings or rust, 4 oz. cinnamon powder, 7 lb. fine sugar, sufficient dissolved gum to make a paste. Stomachic and tonic.

Sulphur.—4 lb. sugar, 8 oz. sublimed sulphur, sufficient gum to make a paste.

Tolu.—4 lb. sugar, 3 dr. balsam of tolu (or 1 fl. oz. tincture), 6 oz. cream of tartar (or 1 dr. tartaric acid), sufficient dissolved gum to make a paste. Flavour by adding ¼ oz. vanilla, and 60 drops essence of amber. Reduce to fine powder with the sugar. Pectoral and balsamic.

Vanilla.—4 lb. sugar, 6 oz. vanilla powder, or sufficient to give strong flavour. Make into paste with dissolved gum.

Worm.—(1) 7 lb. fine sugar, 4 oz. calomel washed in spirits of wine, 1 dr. saffron, sufficient dissolved gum tragacanth to make a paste. Make a decoction of the saffron in ¼ pint water, strain, and mix. Each lozenge should contain 1 gr. mercury. (2) 7 oz. calomel washed in spirits of wine (termed "panacea"), 3½ lb. jalap resin, 9 lb. fine sugar, sufficient dissolved gum to make a paste. Each lozenge should contain ½ gr. mercury. (3) 1 oz. panacea, 2 oz. jalap resin, 2 lb. sugar. Dissolve sufficient gum in rose-water to make a paste. Make 2520 lozenges, weighing 8 gr. each, and containing ¼ gr. calomel and ½ gr. jalap. These should be kept very dry, as damp, acting on the sugar and mercury, generates an acid. In mixing all medicated lozenges, the different powders should be well mixed with the sugar, in order that each lozenge may have its due portion.

Yellow Pectoral.—1 lb. sugar, 12 dr. Florence orris-root powder, 6 dr. liquorice root, 1 oz. almonds, 4 scr. saffron powder, sufficient dissolved gum to make a paste. Make decoction of the liquorice to moisten the gum.

Zinc.—1 oz. sulphate of zinc, 4 lb. sugar. Mix into a paste with prepared gum. Each lozenge should contain ½ gr. zinc.

Much additional information will be found in the *Confectioners' Handbook*, by E. Skuse, with prices of the various necessaries.

COPYING.—This term forms a convenient heading for an article embracing the various processes employed in obtaining copies or impressions of printed and written matter, such as letters, drawings, &c. The subject may be divided into chemical (including photographic) and mechanical methods, copying pencils, and transferring.

Chemical Methods.—(1) Cyanotype, or ferro-prussiate paper. This is prepared by covering one side of the sheet with a mixture of red prussiate of potash (ferrocyanide of potassium) and peroxide of iron; under the influence of light, i. e. under the white portions of the drawing to be copied, the ferric compound is reduced to the state of a ferrous salt, which gives with the red prussiate of potash an intense blue colouration, analogous to Prussian blue.

This colouration is not produced in the portions of the sensitive paper protected from the light by the black lines of the drawing to be copied, and on washing the print the design appears in white lines on a blue ground. The formula for preparing the sensitive paper is as follows:—Dissolve 10 dr. red prussiate of potash (ferrocyanide) in 4 oz. water; dissolve separately 15 dr. ammonio-citrate of iron in 4 oz. water; filter the 2 solutions through ordinary filtering paper, and mix. Filter again into a large flat dish, and float each sheet of paper to be sensitized for 2 minutes on the surface of the liquid, without allowing any of this to run over the back of the paper. Hang up the sheets in a dark place to dry, and keep from light and dampness until used. They will retain sensitiveness for a long time. The paper being ready, the copy is easily made. Procure either a heavy sheet of plate glass, or a photographer's printing frame, and lay the drawing to be copied with the face against the glass; on the back of the drawing lay the prepared side of the sensitive paper, place upon it a piece of thick felt, and replace the cover of the printing frame, or in some other way press the felt and papers firmly against the glass. Expose, glass side up, to sunshine or diffused daylight, for a time, varying, with the intensity of the light and the thickness of the paper bearing the original drawing, from minutes to hours. It is better to give too much than too little exposure, as the colour of a dark impression can be reduced by long washing, while a feeble print is irremediably spoiled. By leaving a bit of the sensitive paper projecting from under the glass, the progress of the colouration can be observed. When the exposure has continued long enough, the frame is opened and the sensitive sheet is withdrawn and thrown into a pan of water, to be replaced immediately by another, if several copies are desired, so that the exposure of the second may be in progress while the first is being washed and fixed. The water dissolves out the excess of the reagents used in the preparation of the paper, and after several washings with fresh water the print loses its sensitiveness and becomes permanent. It is advantageous, after several washings with water, to pass over the wet surface a weak solution of chlorine or of hydrochloric acid, 3 or 4 parts acid to 100 of water, which gives brilliancy and solidity to the blue tint, and prevents it from being washed out by long soaking. This should be followed by 2 or 3 rinsings with fresh water, and the print may then be hung up to dry, or placed between sheets of blotting-paper. This mode of reproduction, whose simplicity has led to its adoption in many offices, has the inconvenience of giving a copy in white lines on blue ground, which fatigues the eye in some cases, while the application of other colours is impracticable. By repeating and reversing the process, copying the white line print first obtained on another sensitive sheet, a positive picture, representing the black lines of the original by blue lines on white ground, can be obtained; or the same result may be reached by a different mode of treating the sensitive paper. This latter may also be made by brushing it over with a solution of ferric oxalate (10 gr. to the oz.); the ferric oxalate is prepared by saturating a hot aqueous solution of oxalic acid with ferric oxide. A better sensitizing solution may be made by mixing 437 gr. ammonium oxalate, 386 gr. oxalic acid, and 6 oz. water, heating to boiling-point, and stirring in as much hydrated peroxide of iron as it will dissolve.

(2) Several varieties of paper called "cyanoferric," or "gommoferric," are sold, which have the property of giving a positive image. The mode of preparation is nearly the same for all: 3 solutions, 1 of 60 oz. gum arabic in 300 of water; 1 of 40 oz. ammoniacal citrate of iron in 80 of water; 1 of 25 oz. perchloride of iron in 50 of water, are allowed to settle until clear, then decanted, mixed, and poured into a shallow dish, the sheets being floated on the surface as before, and hung up to dry. The solution soon becomes turbid,

and must be used immediately, but the paper once dry is not subject to change unless exposed to light or moisture. The reactions involved in the printing process are more complex than in the first process, but present no particular difficulty. Under the influence of light and of the organic acid (citric), the perchloride of iron is reduced to protochloride, and, on being subjected to the action of ferrocyanide of potassium, the portions not reduced by the action of the light, that is, the lines corresponding to the black lines of the original drawing, alone exhibit the blue colouration. The gum plays also an important part in the process by becoming less soluble in the parts exposed to light, so as to repel in those portions the ferrocyanide solution. The mode of printing is exactly the same as before, but the paper is more sensitive, and the exposure varies from a few seconds in sunshine to 15 or 20 minutes in the shade. The exact period must be tested by exposing at the same time a slip of the sensitive paper under a piece of paper similar to that on which the original drawing is executed, and ruled with fine lines, so that bits can be torn off at intervals, and tested in the developing bath of ferrocyanide of potassium. If the exposure is incomplete, the paper will become blue all over in the ferrocyanide bath; if it has been too prolonged, no blue whatever will make its appearance, but the paper will remain white; if it is just long enough, the lines alone will be developed in blue on a white ground. During the tests of the trial bits, the printing frame should be covered with an opaque screen to prevent the exposure from proceeding further. After the exact point is reached, the print is removed from the frame and floated for a few moments on a bath of saturated solution of ferrocyanide of potassium, about 1 oz. of the solid crystals to 4 of water. On raising it, the design will be seen in dark blue lines on white ground. It is necessary to prevent the liquid from flowing over the back of the paper, which it would cover with a blue stain, and to prevent this the edges of the print are turned up all round. On lifting a corner, the progress of the development may be watched. As soon as the lines are sufficiently dark, or blue specks begin to show themselves in the white parts, the process must be immediately arrested by placing the sheet on a bath of pure water. If, as often happens, a blue tint then begins to spread all over the paper, it may be immersed in a mixture of 3 parts sulphuric or 8 of hydrochloric acid, to 100 of water. After leaving it in this acidulated liquid for 10 or 15 minutes, the design will seem to clear, and the sheet may then be rinsed in a large basin of water, or under a faucet furnished with a sprinkling nozzle, and a soft brush used to clear away any remaining clouds of blue; and finally, the paper hung up to dry. The ferrocyanide bath is not subject to change, and may be used to the last drop. If it begins to crystallize by evaporation, a few drops of water may be added. The specks of blue which are formed in this bath, if not removed by the subsequent washings, may be taken out at any time by touching them with a weak solution of carbonate of soda or potash. The prints may be coloured in the usual way.

(3) Blue figures on a white ground are changed into black by dipping the proof in a solution of 4 oz. common potash in 100 oz. water, when the blue colour gives place to a sort of rusty colour, produced by oxide of iron. The proof is then dipped in a solution of 5 oz. tannin in 100 oz. water. The iron oxide takes up the tannin, changing to a deep black colour; this is fixed by washing in pure water.

(4) Joltrain's. Black lines on white ground. The paper is immersed in the following solution:—25 oz. gum, 3 oz. chloride of sodium, 10 oz. perchloride of iron (45° B.), 5 oz. sulphate of iron, 4 oz. tartaric acid, 47 oz. water. The developing bath is a solution of red or yellow prussiate of potash, neutral, alkaline, or acid. After being exposed, the positive is dipped in this bath, and

the parts which did not receive the light take a dark green colour; the other parts do not change. It is then washed with water in order to remove the excess of prussiate, and dipped in a bath containing acetic, hydrochloric, or sulphuric acid, when all the substances which could affect the whiteness of the paper are removed. The lines have now an indigo black colour. Wash in water, and dry.

(5) Copies of drawings or designs in black and white may be produced upon paper and linen by giving the surface of the latter two coatings of: 217 gr. gum arabic, 70 gr. citric acid, 135 gr. iron chloride, ½ pint water. The prepared material is printed under the drawing, and then immersed in a bath of yellow prussiate of potash, or of nitrate of silver, the picture thus developed being afterward put in water slightly acidified with sulphuric or hydrochloric acid.

(6) Benneden states that paper, prepared as follows, costs but $\frac{1}{6}$ as much as the ordinary chloride of silver paper, is as well adapted to the multiplication of drawings, and is simpler in its manipulation. A solution of bichromate of potash and albumen or gum, to which carbon, or some pigment of any desired shade, has been added, is brushed, as uniformly as possible, upon well-sized paper by lamplight, and the paper is dried in the dark. The drawing, executed on fine transparent paper (or an engraving, or wood-cut, &c.), is then placed beneath a flat glass upon the prepared paper, and exposed to the light for a length of time dependent upon the intensity of the light. The drawing is removed from the paper by lamplight, and after washing the latter with water, a negative of the drawing remains, since the portions of the coating acted on by the light become insoluble in water. From such a negative, any number of positives can be taken in the same way.

(7) Dieterich's copying-paper. The manufacture may be divided into 2 parts, viz. the production of the colour and its application to the paper. For blue paper, he uses Paris blue, as covering better than any other mineral colour. 10 lb. of this colour are coarsely powdered, and mixed with 20 lb. ordinary olive oil; ¼ lb. glycerine is then added. This mixture is, for a week, exposed in a drying-room to a temperature of 104° to 122° F. (40° to 50° C.) and then ground as fine as possible in a paint mill. The glycerine softens the hard paint, and tends to make it more easily diffusible. Melt ½ lb. yellow wax with 18¾ lb. ligroine, and add to this 7½ lb. of the blue mixture, mixing slowly at a temperature of 86° to 104° F. (30° or 40° C.). The mass is now of the consistence of honey. It is applied to the paper with a coarse brush, and afterward evenly divided and polished with a badgers' hair brush. The sheets are then dried on a table heated by steam. This is done in a few minutes, and the paper is then ready for the market. The quantities mentioned will be sufficient for about 1000 sheets of 36 in. by 20, being a day's work for 2 girls. For black paper, aniline black is used in the same proportion. The operation must be carried on in well-ventilated rooms protected from fire, on account of the combustibility of the material and the narcotic effects of the ligroine. The paper is used between two sheets of paper, the upper one receiving the original, the lower one the copy.

(8) A process similar to autoscopy. The pad is prepared with glue, glycerine, and water, in the same manner as for the well-known hectograph, but with a larger proportion of glue. For writing or drawing, a concentrated solution of alum is used, coloured with a little aniline to render the writing visible. Before using, the pad is damped by means of a wet sponge, and the moisture is permitted to remain a few minutes. The writing may now be applied, and upon removing it, after a short time, the lines will be transferred to the pad. A small quantity of printers' ink is applied with a rubber roller, and will be taken up by the etched lines only. An impression is obtained by pressing moistened paper over the lines with the

palm of the hand. The pad must be inked for each copy, but a great number may be made from the same etching or transfer.

(9) Paper prepared so that a brass pointer leaves a black mark on it. Dissolve ¼ oz. pure sodium sulphide and ½ oz. sodium hyposulphite in 1 qt. rain water; filter the solution, and with it uniformly moisten the surface of the paper; then dry the latter under pressure between clean blotting paper.

(10) Tilhet's process. The paper upon which the design is to be reproduced, in order to prepare a negative copy, is first passed through a bath composed of 30 oz. white soap, 30 oz. alum, 40 oz. Flanders glue, 10 oz. white of eggs or albumen beaten up, 2 oz. glacial acetic acid, 10 oz. alcohol at 60°, 500 oz. water. The paper, after having been removed from this bath, is passed through a second bath composed of 50 oz. burnt umber, ground in alcohol, 20 oz. black pigment, 10 oz. Flanders glue, 500 oz. water, 10 oz. bichromate of potash. The paper having been thus treated, must be kept when dry in a dark place. In order to prepare positive paper for the prints, a bath is used similar to the last, but without the umber, for which black pigment is substituted. To obtain coloured proofs instead of black ones, the black pigment is replaced by a pigment of any desired colour. To prepare the copies, the design or drawing is placed in an ordinary photographic printing-frame, the back of the design being next to the glass, and a sheet of negative paper prepared in the way first described is placed in contact with it. The frame is then exposed to light, 2 minutes' exposure being sufficient in good weather. The sensitive paper is then removed from the frame in a dark place and is placed in water, when the design becomes visible in white, and the paper is allowed to dry. In order to obtain positive pictures from the negative thus prepared, the latter is placed in the printing-frame with a sheet of the positive paper prepared in the manner above described in contact with it, and after exposure to light for a sufficient time (about 2 minutes), the positive paper is removed in a dark place, and is plunged into water, which removes the part of the pigment which has not been affected by the light, without its being necessary to touch it. Any number of copies of the design or drawing may be produced upon any kind of paper, and in any colour or colours. The proportions of the different materials used to prepare the baths may be varied to suit circumstances, such as the weather, and the character of the design or of the paper.

(11) Zuccato's "papyrograph." A sheet of fine paper is saturated with a resinous varnish, and dried. On it, writing is made with an ink consisting of a strong solution of caustic soda, slightly coloured in order to be more obvious to the eye. The soda immediately attacks the resinous preparation of the paper, converting it into a soap. The sheet is floated on water, written side upwards; the water soon penetrates the softened parts, making the written lines stand up in bold relief as ridges of fluid. The paper is removed from the surface of the water, and pressed between folds of blotting-paper, after which it is once more floated on the surface of the water, and again blotted off, in order to remove the remainder of the resin soap. The sheet thus prepared forms a stencil, of which the general ground is impervious to moisture, while the written lines, being denuded of varnish, are quite porous, and afford an easy passage to an aqueous liquid. In the early days of papyrograph printing, a pad, saturated with persulphate of iron, was placed at the back of the stencil, while the paper to be printed on was moistened with a solution of ferrocyanide of potassium. The iron salt being forced through the porous lines by a gentle pressure, reacted on the ferrocyanide; a blue impression was the result. It is now, however, found to be more convenient to print from the stencil by means of an aniline colour dissolved in glycerine, and the colouring power of this kind of ink

is so great that dry paper may be used for receiving the impression. On a velvet pad which has been moistened with a solution of aniline blue in glycerine, is laid the paper stencil, this having been previously brushed over at the back with a little of the ink. It is now merely necessary to place sheets of paper on the upper face of the stencil, and to apply gentle pressure by means of an ordinary copying-press, in order to obtain copies rapidly and easily. About 600 copies can generally be taken from one stencil.

(12) Pumphrey's "collograph" depends on the fact that when a film of moist bichromated gelatine is brought into contact with ferrous salts, tannin, or certain other substances, the gelatine is so far altered as to acquire the property of attracting a fatty ink. Pumphrey supplies plates of slate or glass covered on one side with a thin film of gelatine, and these are prepared for use by being soaked in a weak solution of potassium bichromate, all excess of moisture being then removed by first wiping with a cloth, and afterwards rolling paper on the damp surface. A drawing or writing, which has been made with either an ordinary iron and gall-nut ink, or with a special ink, is transferred to the prepared plate, just as in the case of the transfer to zinc. The original being removed, the plate is inked by means of a roller, moistened by a sponge, in order to remove any trace of ink from the ground, and then printed from, much as if it were a lithographic stone, or a zincographic plate.

(13) Some methods depend on the writing of an original with a very intense ink, and then dividing the ink, so as to obtain a number of feebler copies. The ordinary method of obtaining one or two reverse copies of a letter on thin paper is of this nature; but these processes, which are capable of yielding 30 to 60 fairly good copies, depend on the use of a solution of an aniline colour for writing. In the case of copying processes introduced by Pumphrey and Byford, the writing is executed with a strong solution of an aniline colour on thin, and tolerably hard, paper. The writing quite penetrates the thin paper, and on pressing a sheet of moistened paper against the back of the original, some of the aniline colour will set off on the damp paper, giving a direct copy of the original writing. In the same way, numerous copies may be produced; but processes of this kind cannot reproduce very fine lines with distinctness. A somewhat analogous arrangement for obtaining numerous copies is afforded by Waterlow's "multiplex copying portfolio" and its contents. The writing is done with the aniline ink, and a damp sheet of very soft and porous paper is pressed down on the writing. This soft paper absorbs a large proportion of the aniline ink, and itself forms a reversed printing-surface, capable of yielding a considerable number of direct copies to damp sheets of paper.

(14) Hectograph or Chromograph. This process obviates the necessity for using damp paper to receive the impression. The writing is executed on ordinary writing-paper with aniline ink, and when the lines have dried, the original is transferred to the surface of a slab of soft gelatinous composition, analogous to that used for making printers' rollers, contact being established by gentle rubbing with the hand. The original, after being allowed to remain in contact with the gelatine slab for about 2 minutes, is stripped off, leaving the greater part of the ink on the gelatine. To obtain copies, it is merely necessary to lay paper on the slab, and rub down with the hand or a soft pad. When the requisite number of copies is obtained, or the lines are effaced, the slab can be cleaned with a damp sponge, and is again ready for use. The composition for the slab may be prepared thus:—1 lb. gelatine (or 1½ lb. glue) is soaked in water till it becomes flaccid, after which it is melted in a water-bath with 6 lb. common glycerine, the heat being maintained for a few hours to drive off all excess of water. The mixture is poured into zinc trays ½ in. deep, and allowed to set. Another

composition is 130 parts water, 75 baryta sulphate, 30 gelatine, 30 sugar, 180 glycerine. The ink is prepared by dissolving 1 part aniline blue-violet in a mixture of 7 parts water and 1 alcohol. Coloured inks will give 150 copies, and special black ink 50.

(15) Magne has introduced an ink or pencil possessed of such qualities that a writing or drawing made with it, when dry, can be covered with a fatty ink, and the paper being saturated with a suitable liquid, it can be completely copied without being injured itself. Common printing ink acts towards this saturating fluid in the same way as Magne's pencil, so that printed matter and cuts can be reproduced. The liquid employed to saturate the paper consists of 15 oz. acid (sulphuric is the best) and 35 oz. alcohol. If intended for autographic reproduction, 100 oz. water should be added. The proportions may be varied, but to prevent injury to the original, there must be plenty of alcohol. Autographs for reproduction must be written with ink or pencil, of such composition that they can take up the fatty ink; the same kind is used for all kinds of paper, whether sized or not. The portions of the paper not covered with ink are protected against the lithographic ink by an acid composition which repels the greasy ink, does not attack the cellulose, and, therefore, leaves the original perfectly unchanged. The ink consists of proteine substances (albumen, caseine, fibrine, &c.), and of bichromated salts, alum, cyanides, &c. In making it there is dissolved a quantity of water 2 or 3 times as great as that of the albumen or other proteine substance, a mixture of 2 parts of a bichromate or alum, and 1 of prussiate of potash. A certain quantity of albumen is also beaten up with an equal weight of water. The proportion of salts to that of albumen is about as 6 to 100. The two liquids are mixed intimately, and a suitable quantity of pigment is added. The ink, which must have pretty deep colour, is unchangeable, remains thin and fluid, and can be used with a pen, pencil, or drawing pen, on any kind of paper, except very heavy paste-board or too thin silk paper. Pencils or crayons used in this process consist chiefly of paraffin coloured with very fine lamp-black or ivory-black, or with any other very finely-powdered pigment for other colours. When lamp-black is used, the proportions are, 16 oz. lamp-black to 100 oz. paraffin. To make pencils of different hardness, the paraffin is melted and the colour added, and then a certain quantity of ordinary rosin (colophony) is added, usually not over 10 per cent. The mass is cast into candle moulds when in a semi-liquid state, and taken out when cold. These cylinders are then cut in pieces and wrapped in strong paper, or covered with wood like common lead pencils. The method of taking a copy of what has been written or drawn is as follows: If the work was done in ink, it is ready to copy as soon as dry. If in pencil, the drawing must be steamed a few seconds by holding it over a vessel of boiling water. After being air-dried, it is carefully floated, face upward, on the acidified alcoholic liquid. There it is left until thoroughly saturated, and then it is spread out on a sheet of glass or smooth board, and inked with an ordinary lithographic roller. All the letters and lines will be covered with the greasy ink. As soon as sufficiently inked, it is carefully pressed with a damp sponge on those places that have taken the ink, and then washed with water. To remove the excess of moisture, it is spread out on a plate of plaster-of-Paris, and then transferred to a stone or zinc plate, and the copy taken. The precautions necessary in order to preserve the original copy are to wash it with carbonate of ammonia, or of soda, rinsing with cold water, removing the excess of water on a plate of gypsum or blotting-paper, and then drying it in the press between sheets of porous paper. To reproduce anything printed with printers' ink, the following method is pursued:—The mixture of alcohol and acid is applied either to the face or back of the print with a brush. The liquid instantly

penetrates the paper; the surface is then quickly washed off and the sheet carefully spread out on a damped plate of glass or wood. There it is inked with an ordinary lithographic ink roller, gently washed to remove the excess of acid, dried on the gypsum plate, put on the stone, and a sufficient pressure applied. The transfer of the negative is finished, and the ordinary lithographic process begins. If both sides of a drawing or manuscript are to be copied, both sides are blackened, one after the other, the operation being carried out on one side as far as the transfer to a stone, and then the other side is inked and transferred. When copies of printed matter are to be made, the negative is transferred to a polished zinc plate, and then etched in the usual manner with acids.

(16) Willis's process is founded on the action of bichromates on organic matter, the printed image being coloured by means of an aniline salt; it is extremely useful for copying plans and simple line-subjects. The operation is as follows:—Sized paper is floated in potassium bichromate containing a little phosphoric acid; it is next exposed beneath a translucent positive, and when the image of the latter is clearly shown, it is subjected to the action of aniline vapour. The result is that the parts shielded from the light by the lines of the positive are deeply coloured (green, black, or reddish, according to the aniline salt used), while the other parts retain the weak tint of the reduced chromium oxide. In developing the print, it is exposed to the contact of the vapour from aniline dissolved in spirit of wine, the solution being placed in a basin, and heated by a spirit-lamp. The prints are fairly permanent after washing.

(17) Poitevin's Powder.—A mixture of gum arabic, sugar, and glycerine, with some sensitizing solution of potassium bichromate, is poured upon an impervious surface (e.g. a glass plate), and dried by warmth. Thus prepared, the plate is immediately exposed beneath a translucent positive for a few minutes. The parts affected by the light become hygroscopic, in proportion to the duration of the exposure, and intensity of the light, and any impalpable powder delicately brushed over the plate will adhere to the hygroscopic parts, according to their degree of moisture, thus forming a reversed copy. The developed image is coated with collodion, and transferred to paper unreversed, the soluble bichromate being washed out in the operation. [illegible]

[illegible] bichromate, 2 to 6 drops glycerine for every 100 cc. of water, and 96 parts water. The glass plate is sometimes previously coated with collodion.

(18) Woodbury-type.— Woodbury's process is intended to produce a mould of a gelatine print from which other prints may be obtained. A thick film of sensitive gelatine, resting on a tough stratum of collodion, is placed beneath a negative with the collodion side next the image. After sufficient exposure to a light so arranged that the rays always fall in one direction, the gelatine picture is developed as if it were an autotype print, and presents the image in considerable relief. After drying, it is laid on a perfectly flat metallic plate, and a sheet of lead or some other soft metal is forced down upon it by a powerful press. The metallic sheet, being an exact mould of the gelatine picture, is put into a special press, and a viscous compound of gelatine dissolved in hot water, with the addition of fine pigment or permanent dye, is poured upon this sheet. Strongly-sized paper, of even texture, is placed upon the viscous compound, and the top plate of the press is brought down upon the mould, and firmly held, thus squeezing out the superfluous gelatine. The gelatine soon sets, when the top is raised, and the paper bearing the picture is detached. The print is immersed in alum solution, to render the impression insoluble. The top plate of the press is made of thick glass, and its surface is a perfect plane, to ensure the gelatine being squeezed out from the portions which are to be white in the

picture, and to prevent a mottled and uneven appearance. Within certain limits concerning the size of white surface which can be produced (owing to the variations in the thickness of all paper), this process is capable of producing permanent images at a price but little greater than the cost of the paper and solution.

(19) Photo-lithography. · Another process founded on the insolubility of gelatine when treated with a bichromate and exposed to light, is one capable of producing pictures in printing-ink, as well as in ink adapted to transferring to zinc or stone, images being reproduced by ordinary surface-printing from the transferred prints. The photographic negative is placed in a photographic printing- or pressure-frame, with a piece of prepared paper face downwards upon the picture side of the glass. The back is made secure, and the glass side is exposed to the light; in due time, it is taken to the dark-room, and coated with transfer-ink. Washing removes the transfer-ink from those parts which have not been affected by the light (the white parts of the paper), but leaves it where the light has acted (the lines of the picture); thus a photographic transfer is produced, and may be applied to stone or zinc, and printed from in the usual manner. The sensitizing solution is prepared as follows:—1 to 1½ oz. of gelatine (the smaller quantity if "flake") is set to soak in sufficient water to cover it; meantime, 1 oz. of potassium bichromate is dissolved in 5 oz. water, and filtered; when the gelatine has plimmed, pour on sufficient boiling water to make 11 oz., and add the bichromate solution. Sometimes a dash of glycerine is added. This solution will keep good for a considerable time in a cool place. To prepare the paper, some of the solution is warmed to about 100° F. (38° C.), and sheets of the paper ("bank post," "positive photographic," or other fine-wove and slightly sized) are floated on it for 2 to 3 minutes, and hung up to dry in the dark-room, then again floated, and suspended from the opposite end. The sensitized paper is exposed in the ordinary manner beneath a negative in the pressure-frame, until the lines appear of a fawn-colour on a yellow ground. The picture is transferred to stone or zinc by coating the latter with ink, laying the former face downwards upon it, and pulling through the press. Ordinary chalk lithographic ink may be used for single prints, but a superior ink is made as follows:—16 oz. lithographic ink and 8 oz. middle linseed varnish are first mulled together; 6 oz. Burgundy pitch and 2 oz. bitumen are melted over a clear fire till all the water is driven off; 1 oz. white wax is also melted; the whole is then mixed together, with 1 oz. palm-oil, and run into vessels for keeping. The print is developed by being floated back downwards on water at a temperature of 100° to 122° F. (38° to 50° C.), till the lines appear as depressions. It is then washed with water at about 158° F. (70° C.) on an inclined slab, by which the soluble gelatine is removed with the ink that coated it, and the image remains as ink lines on ridges of insoluble gelatine. The developed print is washed in cold water, and hung up to dry; it is then ready for transferring to stone or zinc, being first damped till it becomes limp. The subsequent manipulation is a mere repetition of lithographic printing.

(20) Niépce's Process.—Relief processes are those which produce plates or blocks with raised lines, capable of being printed from like type in an ordinary printing-press. They are adapted only to line drawings, and are unsuited for the reproduction of toned work. Engraved plates have the lines of the original drawing in depression, and are adapted to the same class of work as relief processes. Both are produced by the same general method and on the same principles, of which the following is an outline. The foundation of the system is the fact that asphalt or bitumen, when exposed to light, becomes insoluble in its ordinary solvents if partially saturated. In Niépce's process, the first based on this ground, silver plates were coated with bitumen, the unaltered portions of which were

dissolved away after exposure; iodine was applied, the remaining bitumen was removed, and the result was a metallic silver image on a ground of silver iodide. The solvent generally employed is chloroform. The coated plate is dried, and exposed beneath a subject. The portions to be protected from the influence of the light will depend upon whether the plate is to be engraved or in relief; in the former case, the lines will need protection. Care must be taken that the opacity, where required, is perfect. For engraved plates, a reversed positive is necessary; for relief blocks, an ordinary unreversed negative. The original picture is placed in contact with the prepared plate, and exposed as long as is considered necessary; the soluble portions of the bitumen are then removed by a nearly saturated solvent, leaving the metal bare. This latter may be zinc, copper, or steel; the first is most commonly used for relief blocks, while the two last are more convenient for engraving. The "biting-in," or development of the lines, is effected, in the case of zinc, by simple hydrochloric acid, though it is advisable to previously dip the plate in a sulphate of copper solution; for copper and steel, a mixture of hydrochloric acid and potassium chlorate is preferred. With relief blocks, the biting-in is a tedious operation, having to be carried as deep as in a wood-block. After the first biting, which gives the clear lines, the plate is heated, dusted over with resin, and reheated to make the bitumen quit the lines, these operations being repeated till sufficient depth is attained. In appreciably large spaces, the metal is removed by engravers' tools.

(21) Ehrard's biting-in process differs somewhat from the preceding. A transfer is prepared as for zincography, transferred to a copper plate, and plunged into an electro-plating bath for a few minutes, thus coating the copper with a thin silver film, while the lines are protected by the greasy ink; the plate is rinsed in dilute acid, and placed in a mercuric chloride bath, where a double chloride is formed; after washing, and removal of the ink, the biting-in proceeds.

(22) Fox Talbot proposed a modification, which consisted in printing the negative on a gelatine film, washing away the unaltered gelatine, and making an electrotype.

(23) Scamoni's process.—The originals which have to be reproduced are carefully touched up, so that the whites are as pure, and the blacks as intense, as possible, and then the negative is taken in the ordinary way, the plate being backed in the camera with damp red blotting-paper, to prevent reflection from the camera, or back of the plate. The negative is developed in the ordinary manner, intensified by mercuric chloride, and varnished. A positive picture is taken in the camera, the negative being carefully screened from any light coming between it and the lens. This is intensified by pyrogallic acid, and afterwards washed with pure water to which a little ammonia has been added. It is then immersed in mercuric chloride for ½ an hour, and again intensified with pyrogallic acid. This is repeated several times. When the intensity of the lines is considerable, the plate is well washed, treated with potassium iodide, and finally with ammonia, the image successively appearing yellow, green, brown, and then violet brown. The plate is then thoroughly drained, and the image is treated successively with a solution of platinic chloride, auric chloride, ferrous sulphate, and finally by pyrogallic acid, which has the property of solidifying the metallic deposits. The metallic relief thus obtained is dried over a spirit lamp, and covered with an excessively thin varnish. This varnish, which is evidently a special preparation, retains sufficient tackiness to hold powdered graphite on its surface (bronze powder may be employed instead), which is dusted on in the usual manner. After giving the plate a border of wax, it is placed in an electrotyping bath, and, after a few days, a perfect facsimile in intaglio is obtained.

(24) The editor of the *British Journal*

of Photography writes:—The great secret in obtaining a successful negative from an oil painting, is to have it illuminated entirely by diffused light. Some Continental artists who are very successful in this branch of photographic work, lay the painting flat on the ground, and point the camera downwards.

(25) Zincography is thus described by Nuth:—The zinc plate with the transfer laid on is first gently warmed over a gas or spirit lamp; when cooled, finely-powdered resin is dusted over it out of a linen bag; this is brushed over the plate by means of a round camel-hair-brush, an even circular motion being maintained. When sufficient resin has adhered to the plate, it is again warmed, to ensure its firm connection with the fatty design; the plate is then cooled in cold water, and allowed to remain a few minutes in a 3 per cent. solution of commercial nitric acid, until a depth of about ·005 in. is obtained. This depth has to be determined by frequent experiment, as it is very important it should not be exceeded. The plate is now bitten to such a trivial degree that the lines are not under-bitten to any appreciable extent, and it may be mentioned that this first etching is the key-stone to the rest. If it "goes wrong" you cannot doctor up your plate, and you may save further trouble by beginning afresh. When dry, it is again dusted with resin, and warmed, the fringe of resin thus adhering to the sides of the lines, serving to protect the etched part from any further action of the acid; the plate is then rubbed over lightly with strong gum mucilage, which is immediately washed off. A roller charged with lithographic ink (No. 2, mixed with middle varnish, is the best), is then passed over it, backwards and forwards, several times, so that more ink may adhere to the lines. Coarser resin is now sifted on, and it is heated more strongly. This causes the ink to melt, and cover the resin fringe, and thus form a secure acid-proof varnish. To a careful observer, the lines will appear thicker after every heating. The strength of the acid is now increased to 5 per cent., and the plate is bitten about ·015 in.; when dry, it is again resined, heated, cooled, gummed, inked, resined and heated just as before, each time the processes being carried further than the last. Ordinary plates—such as the illustrations to the *Figaro*—have to be bitten about 8 to 12 times, while very fine ones, such as transfers from steel engravings, have often to be etched as many as 20 times—of course proportionately less for each time. These instructions will enable any one of ordinary manipulative ability to engrave zinc plates very fairly, but it requires something more than mere formulæ and advice to finish off the fine tint and crayon drawings so beautifully and delicately as they are done by Gillot, Zimmerman, and other clever French engravers. Years of practice are wanted, and each individual has his own particular pet mode of working which suits him best, and which he considers as superior to all others, and jealously retains as a trade secret.

(26) Phototypy is a sort of lithography in which the stone is replaced by a hygroscopic layer of gelatine impressed with an image by the action of light passing through a photographic negative. Now, if we could cut down a lithographic stone both in its surface dimensions and its height, to make it like a wood block, we should be able to insert it in the text, and take an impression from it simultaneously with that from the type. The difficulties in the way of doing this would be, firstly, the necessity of wetting the stone previous to each impression; and, secondly, the expense of cutting down lithographic stones, which would entirely lose their value in the process. But what we are on this account prevented from effecting with natural lithographic stones can be managed with an artificial one, provided that the latter possesses a hygroscopic surface from which, after being saturated with water, numerous impressions can be taken without its being necessary to wet it afresh. It became, therefore, necessary to make photo-printing blocks

of the requisite size and height to be set up in the "forme" with ordinary type, and possessing so great a hygroscopic quality that the moistening requisite to produce an impression should only be an accidental operation, and not one that is indispensable before each pull. The ordinary process of phototypy was scarcely adapted for this purpose without modification. The plates in this process are made of metal or glass, or even lithographic stone, always larger than the image of which it is required to obtain an impression, and it would be impossible in every case to cut these plates to the size of the printing block. Vidal adopts another method for arriving at the same result as that produced by ordinary phototypy. He prepares the artificial lithographic stone and the hygroscopic support separately, and then attaches the one firmly to the other. The image is obtained as in the ordinary carbon process; an impression on carbon tissue is developed on a roughened glass plate coated with some fatty substance. When, by means of hot water, the picture is divested of all the gelatine not acted on by light, it ought to appear with all its half-tones like a good carbon print which is ready to be transferred to its definite support. This is then enclosed in a frame of thick cardboard, bevelled outwards on the inside, and coated entirely with paraffin or wax; the frame is then filled with the following composition, which is poured into it and over the picture:—308 gr. gelatine, 308 gr. gum arabic, 616 gr. glycerine, 3½ fl. oz. water, 17 fl. oz. ammonia, 8 gr. alum, 185 gr. salicylic acid, 154 gr. barium sulphate. The salicylic acid is added as an antiseptic, and the sulphate of barium gives to the layer of gelatine an opalescent appearance. The whole layer should be so deep as to have, after drying in the chloride of calcium box, a thickness of about 0·2 in. When the desiccation is complete, the layer above the glass plate is turned out, and will be found to have the image transferred to it. We have now, therefore, a plate of gelatine bearing on it the picture of the exact dimensions required, and bevelled downwards from the edges, which latter will, therefore, not take any ink. This plate must then be mounted on a sheet of copper or zinc, which is raised on a wooden support until the height of the image is the same as that of the type with which it is to be printed. The gelatine plate is next saturated with moisture by immersion for ¼ hour in a bath composed of 1¾ oz. glycerine, 1·69 fl. oz. water, 31 gr. alum, and the image will appear on its surface in considerable relief, so as to render it particularly well adapted for printing from. The separation of the black parts of the picture from the white parts of the hygroscopic gelatine is very perfect, so that no smudging, such as so often occurs with printing blocks on which the shadows are modelled by fine lines close together, need be feared. The mixture of which the formula is above given is of so hygroscopic a character that repeated wetting is rarely necessary. It must be effected with a sponge dipped in a mixture half water and half glycerine, after having removed from the plate all trace of ink; but the latter should never be severely washed. In this way is obtained a carbon print, but with a light-coloured pigment, so that the degree of inking can be readily determined. Light-coloured earths in the form of impalpable powders, with a gelatine chosen for its resistent properties, make very good tissue. The print should not be treated with alum before putting on the layer of hygroscopic gelatine, otherwise it will not transfer easily. On the contrary, it is better to wash it with water containing a little ammonia, which will facilitate the penetration; the mixture already contains some ammonia, and the transfer of the image to the plate of glycerine and gelatine is thus rendered completely effectual. The alum contained in the first liquid used for moistening increases the hardness of the image, and prevents it from swelling too much. (*Brit. Jl. Photography.*)

(27) Michaud's process.—A negative of the subject to be reproduced having

been obtained, a print is taken on a film of bichromated gelatine supported by a metal plate. The print is developed by the usual means, and, after being dried in the open air, is placed in a box containing a hygroscopic material, the dampness of which causes the gelatine to swell slightly, and so increase the amount of relief. The secret of Michaud's process consists in pressing this gelatine film into the plastic face of a fusible metal, which is contained in suitable trays or dishes. The "forme," as it is called, is treated in much the same way as the mould and block in the process of electrotyping, being placed under a screw press, and allowed to remain until the metal becomes solid. The fusible alloy used is compounded of 50 parts bismuth, 30 tin, 20 lead, and 11 mercury. The plate produced by impressing the gelatine on the semi-fluid face of the alloy can be employed for the production of other plates; but for the purposes of typography it will be seen that several operations must still be carried out in order to obtain a raised plate in hard metal from a sunk plate in a fusible alloy. When the picture required contains half-tones, it is necessary to obtain a grained surface. This is accomplished by means of a special film of coloured bichromated gelatine, which is exposed under a plate dusted with a rather coarse opaque powder. The film thus produced is attached to the negative by means of a solution of gum arabic, containing a little bichromate of potash, the operation being performed under water. The parts not affected by light are then removed in the usual manner, and a negative is obtained with a grained surface from which the print is taken with which the impression is made.

(28) Chromotype. The negatives for chromotypes should be thinner than those for ordinary uses, and surrounded with an opaque margin of paint or paper. The papers are sensitized by immersion in solution of potassium bichromate (1 salt: 32 water) for about $1\frac{1}{2}$ minute. The duration of immersion depends, however, on the temperature, and the nature of the paper. The more sugar the latter contains, the shorter may be the time of immersion; the paper must remain in the solution till it spreads out quite flat. The drying must take place at low temperatures, otherwise a hard brittle paper is obtained. It is also of importance that the sensitizing liquid should contain no free acid, otherwise a covering is got which does not dissolve in water. The exposure should last but $\frac{2}{3}$ of the time required for silver prints. A piece of silvered paper serves as a photometer; when it has turned brown, the light may be shut off. Of course the intensity of the negative has to be taken into consideration; over-exposure is better than under-exposure. The development or transference of the chromate layer with its invisible image to glass or metal, is effected in the usual way. When the paper has been fastened to the plate, the latter is put into a water bath of about 86° F. (30° C.), which is then slowly raised to a little higher temperature. The developed image is transferred to paper prepared with a solution consisting of 6 dr. gelatine, 12 gr. chrome-alum, $18\frac{1}{2}$ oz. water, 3 dr. glacial acetic acid. The paper is steeped in water at 104° F. (40° C.), and then brought into contact with the developed image. It is more convenient to dispense with this second transference, and to place the image at once upon its permanent surface. In this case, special negatives are required. Chromotypes on tinted and coarse-faced papers appear very elegant. The images prepared as above described are ready for colouring with water colours, &c. If it is intended to paint with much colour, the image should be covered with a watery solution of shellac, which hardens the gelatine. When it is desired to produce an image on ivory, it is necessary to wash the image after exposure to light, in order to remove the residual chromate, otherwise a yellow tinge would be imparted to the ivory.

(29) Much has been done in the task of reproducing half-tone drawings and photographs from nature, by Woodbury, Dallas, Lenoir, and others. A

manager of Goupil's named Roussillon, availing himself of the Woodbury-type process, gives a grain to the picture by the action of light, suitably regulated, and thus obtains a mould capable of giving mezzo-tints from ordinary negatives. They require some mechanical touching-up, however.

(30) Lemoir has recently made public a new process for producing engraved plates from negatives photographed from nature, which is substantially as follows. A metallic plate is lightly coated with a mixture of albumen, carmine, and potassium bichromate. The carmine (for which gamboge and various resins may be substituted with almost equal success) serves both as a dye and to assist in the lifting of the film, by its solubility in ammonia, drawing the albumen with it more or less in the stripping-off, the exposure having taken place upon the upper surface. When the film is stripped off, an image remains formed of albumen, in itself unable to resist the action of acids. It must, therefore, be rendered insoluble. There are two ways by which this may be effected; one is to cause the albumen to absorb a solution of gum lac, dissolved in hot water with borax; the other, and preferable, is to plunge the plate, once stripped, in a solution of potassium bichromate, then drying at about 120° F. (49° C.) The albumen by this means acquires the required resistance to the action of acids. The plate is next engraved, to give it a grain according to the amount of ink it should take up. Upon the unabsorbent and stripped plate, a film is spread, consisting of a solution of bitumen and turpentine mixed with carbonate of lime. When plunged in an acid bath, carbonic acid is liberated; it forms tiny canals, through which the acid attacks the metal more or less quickly, by reason of the thickness of the albumen. The acid bath is composed of water acidulated with nitric and oxalic acids and alum. An oxalate of the metal is thus formed on the sides of the canals, and causes them to adhere to the plate. The texture of the etching is more or less fine according to the length of time the albumen is allowed to absorb the acid. In this state, the plate is finished; it requires only to be dried, and is ready to be printed from immediately. No preliminary preparation is necessary, as the whole operation may be conducted in 3 hours.

(31) Warnerke has recently published some improvements based upon the discovery that a gelatine plate submitted to pyrogallic acid becomes insoluble in the parts exposed to light. The ordinary gelatine process requires very accurately-timed exposure; but with the pyrogallic acid, and using the emulsion on paper, no amount of over-exposure will do harm, provided the developer is sufficiently restrained. The transfer of the image from the paper to glass is very simple. The former is immersed in water, and placed in contact with a glass plate; the superfluous moisture is removed by a squeegee, and the paper is stripped off, leaving the gelatine on the glass, when the application of hot water dissolves all the gelatine not acted upon by the light, and the image is left in relief on the glass. Intensification is effected by mixing with the emulsion a non-actinic colouring matter which is not affected by silver; aniline colours answer the purpose well. Relief is said to be obtained far more easily than by the ordinary bichromatized gelatine, and the process is therefore specially applicable to Woodbury-type. It may also be adapted to engraving, enamelling, and collotype purposes.

(32) Heliotype.—The most important of the many modifications of the collotype process is the "heliotype" invented by Ernest Edwards, wherein the great advantage consists in toughening the gelatine film by means of chrome-alum. His method is briefly as follows: The solution of gelatine and bichromate, with the due proportion of chrome-alum, is poured upon the previously waxed surface of a carefully levelled glass plate, and dried, when the film is readily detached. The latter resembles a piece of thick paper, and may be similarly handled. After exposure in contact with a negative, the film is

placed on a plate of zinc or pewter under water, and firmly attached by passing an indiarubber "squeegee" sharply over the surface of the film. The printing film on its plate is soaked in water sufficiently long to remove the superfluous bichromate, to prevent the further action of the light, and is then ready for the press. This is preferably on the vertical principle, such as the Albion printing-press. The inking possesses peculiar features; a very stiff ink may be used to give the deepest shadows, and this may be followed by a thinner ink, even one more or less coloured, for the half-tones, thus producing a bichromatic effect in a single printing. The time occupied in drying the film is 24 to 36 hours at 90° F. (32° C.); 1500 copies have been successfully taken from one plate; one man can print 200 to 300 copies daily; for very long numbers, it can hardly compete with lithography in price, but for moderate numbers the cost is very small.

(33) Capt. Waterhouse has introduced a modified process as follows:—The sensitive film is laid on flat copper plates, finely grained on one side. After levelling on the drying apparatus, the plates are washed with warm water, and coated on the grained side, while still wet, with a mixture of 230 gr. Nelson's opaque gelatine, and 62 gr. powdered potassium bichromate in 3½ fl. oz. water, adding 1 fl. dr. formic acid when the first are dissolved. This is applied like collodion, and the excess is poured off. The coated plates are replaced in the drying apparatus, and covered over. In about 2 hours at 120° F. (50° C.), the films dry with a fine, even, glossy surface perfectly free from streaks and waviness. It is best to let the plates harden for a day or two before use.

(34) Instead of using a tray filled with a compound to receive the ink, Alissoff employs sheets of "polygraphic" paper, prepared in the following manner:—Sized or unsized paper is coated, on one side, with a composition consisting of glue, or gelatine, glycerine, soap, and water, approximately in the following proportions, which have been found to give good results in practice: 80 lb. animal glue or gelatine, 20 lb. glycerine, 20 lb. soap, 200 lb. water. The paper is occasionally found too sticky for use, depending on the surrounding temperature and the quality of the materials. To obviate this objection, wash the prepared paper with a solution of alum, the strength of which can only be determined by experiments in each case. The paper may be of different thicknesses, and rendered transparent. The ink found to give the best results for written documents is prepared by dissolving 1 lb. aniline in 1¼ lb. alcohol, and adding, when dissolved, as much water as is necessary to render it sufficiently fluid. It may then be bottled for use. In producing the "matrix," take a sheet of prepared paper, and lay it on a sheet of damp flannel, placed upon a zinc plate or an oil paper. Sponge with clean water, or, in hot weather, with water containing a little alum, and place the dry original upon the prepared paper. Over that place another piece of damp flannel, zinc, or oil-paper, and put the whole pile into an ordinary copying-press. A good matrix can be obtained by mere pressure of the hands without a press, although a press is preferable. The text must be written, drawn, or printed with aniline ink, taking care that the pen be quite clean and always full of ink. The ink when dry ought to shine like a metallic surface. In taking copies from the "matrix," after having detached the original, place a sheet of ordinary paper in the place of the original, and proceed in the same way as when producing the matrix; but if copies or "matrices" are to be taken from 2, 4, 6, or 8 pages at once, place a sheet of damped polygraphic paper on each page, with damp flannels and zinc sheets between the leaves, and proceed in the way described.

(35) The Asser process differs from those generally in use principally in regard to the paper employed, which is not sized or gelatined, and, consequently, though bad for transferring, nevertheless is capable of fulfilling a special rôle. Take unsized paper of medium thickness

and fine texture, and apply to the surface, by the aid of a clean sponge, a thin film of starch dissolved in water. After the paper, hung up on a pin, has dried, it is floated with the coated side uppermost, upon a saturated solution of bichromate of potash in distilled water, with which it is at once impregnated; consequently the paper is permitted to float upon the solution but a very short time. It is then hung in the dark to dry, and at the lowest corner is put a tiny piece of bibulous paper to absorb the superfluous liquid. As soon as the paper has completely dried, it is put into a printing-frame, the starch-coated side against the negative, which should be pretty vigorous and clear. After printing for a longer or shorter time, a clear, brown image appears upon an orange-yellow ground. When sufficiently printed, the paper is put, image uppermost, in a water bath, care being taken that no air-bubbles are formed between paper and water. It is allowed to float on the water (in the dark) until all the bichromate of potash which has not been acted upon by light is dissolved out, and the picture appears clear and of a light-brown colour; it is then taken out of the water and dried, first of all between leaves of blotting-paper, and then in the air. After drying, the picture is put upon a marble slab, made very hot, taking care, however, that the print does not become brown by heating. By undergoing this operation of heating, the chromate salt is endowed with the property of readily attracting the printing ink. A piece of unsized paper, rather smaller than the picture, is now moistened, flattened upon a piece of patent plate, and the superfluous water removed by the aid of filter paper. Then the image is floated upon its back for a few seconds upon warm water until the water has moistened through the paper and wetted the coating of starch. The image is then taken out of the water and placed upon the sheet of moist paper lying upon the patent plate; in this position the two surfaces are placed in contact, and covered with a dry sheet of sized paper, the latter being rubbed over in all directions by means of a soft cloth, so that the moisture penetrates uniformly, and the whole becomes firmly adherent to the glass plate. The sheet is then taken away, and the image laid bare. In the meantime a stone is brought, such as lithographers employ, together with printers' ink, and litho. ink which is mixed by means of a little oil varnish. With this ink, applied to a bit of flannel, a roller covered with fine cloth is coated as uniformly as possible; the roller is then carefully and without pressure rolled over the image, which soon becomes black, and rapidly assumes vigour as the rolling goes on, while the whites still remain perfectly white. The picture is then in a position to be transferred to stone; the application of the ink to the image must not be carried too far. While the paper is yet damp (so that the paste may adhere to the stone), it is laid upon a lithographic stone, and passed in this way through the press. If the paper holds too fast to the stone, so that it cannot be detached, a little damping of the paper soon brings this about. The image is then to be seen clear and sharp upon the stone, and the printing of copies can then be proceeded with in the ordinary manner in any lithographic workroom. The paper employed in the process for the transfer, being unsized, is easily penetrable by water. Portions, however, of the paper, where the light has acted upon the bichromate of potash covering it, do not become moistened. These parts of the paper, indeed, when heated, will permit any ink to adhere at once.

Unsized paper upon which is formed a print in bichromate of potash, after being heated and moistened with water, behaves, in a word, exactly in the same manner as a lithographic stone; some portions of it attract the ink, while others repel it. Where the light has acted, there the surface becomes hard, and the ink adheres; whereas the other portions yet absorb water, and in this condition repel the ink. If the paper is covered on the image surface with starch, the transfer will have more solidity. ('Photog. Archiv.')

(36) Komaromy, of Budapest, paints a paper with the following solution:—1 oz. gelatine, 5 oz. glycerine, ¼ oz. Chinese gelatine, 1 oz. water. The manuscript is written with the following solution: 100 parts water, 10 of chrome alum, 5 of sulphuric acid, 10 of gum arabic. The manuscript is laid on the first paper, and the surface of the latter is thereby rendered incapable of taking up an aniline solution with which the first surface is then flowed. Excess of colour is absorbed with silk paper, and negative impressions are then taken on clean paper.

Mechanical Methods. — (1) *Stencils.*—A class of printing stencil is made by the mechanical perforation of suitable paper or tissue. Stencils perforated by a rapidly rising and falling needle-point, actuated by a treadle, have long been used for the printing of embroidery patterns. In such a case, powdered colour, mixed with resin, is dusted through the stencil, after which the device is fixed by the application of sufficient heat to soften the resin. Edison proposes to use such perforated stencils for ordinary autographic printing purposes, and replaces the complex treadle perforating machine by a kind of pen, in which a needle-point is made to move rapidly up and down by means of a small electric motor attached to the instrument. When Edison's electric pen is connected with a battery of two elements, the needle rapidly passes in and out of the perforated point of the instrument. If written with on a piece of blank paper, the paper becomes perforated. The sheet of ink-proof paper having been written on with the electric pen, can be used as a printing stencil by merely laying it down on a sheet of white paper and passing an inking-roller over its back. The operation of printing is very rapid, so that many copies can be produced in a short time. Other perforating pens have followed in the wake of Edison's electric instrument, among which may be mentioned the "horograph," a very convenient and portable clockwork pen, manufactured by Newton, Wilson & Co., of Cheapside. A pneumatic pen, in which the motive power is a stream of air supplied from a foot-bellows, has also been introduced into the market. A still more complex and expensive arrangement than either of the preceding, for producing perforated stencils, consists of an induction coil capable of giving a sufficiently powerful spark to perforate the stencil-paper; and this spark is made to continually pass between a partially insulated metallic pen and a metallic plate on which the stencil paper is laid.

(2) All these perforating arrangements have the disadvantages of being expensive, complex in construction, and liable to get out of order when used by unskilled persons, while the perpendicular position in which the mechanical perforating pens must be held, necessarily hampers the freedom of the writer. In a new perforating method recently introduced by Zuccato, the impervious stencil-paper is laid on a hardened steel plate, cut on the face like a fine file, and the writing is executed by means of a point or style of hardened steel. Under these circumstances, the teeth of the file-like plate perforate the paper wherever the point of the style exerts pressure, and a stencil eminently adapted for printing from is the result. This kind of printing is called "trypograph." A sheet of the prepared paper is laid on the file-like plate and written upon with the hardened steel pencil, the operation of writing being as easy as if a pencil were employed. By fixing the stencil on the frame of a desk-like press, placing a sheet of white paper underneath, and then pushing over the upper surface of the stencil an indiarubber scraper or squeegee charged with printing-ink, the ink passing through the perforation produces a copy of the original writing. As many as 6000 copies can be obtained from one stencil. Thin metallic plates are readily perforated by Zuccato's method, and calico receives the trypographic impression admirably.

(3) Tracing on Cloth.—A correspondent of the *Moniteur Industriel* refers

to the difficulties encountered in tracing upon cloth or calico, especially the difficulty of making it take the ink. In the first place, the tracing should be made in a warm room, or the cloth will expand and become flabby. The excess of glaze may be removed by rubbing the surface with a chamois leather, on which a little powdered chalk has been strewn; but this practice possesses the disadvantage of thickening the ink, besides, it might be added, of making scratches which detract from the effect of the tracing. The use of ox-gall, which makes the ink "take," has also the disadvantage of frequently making it "run," while it also changes the tint of the colours. The following is the process recommended: Ox-gall is filtered through a filter paper arranged over a funnel, boiled, and strained through fine linen, which arrests the scum and other impurities. It is then placed again on the fire, and powdered chalk is added. When the effervescence ceases, the mixture is again filtered, affording a bright colourless liquid, if the operation has been carefully performed. A drop or two must be mixed with the Indian ink; and it also has the property of effacing lead-pencil marks. When the cloth tracings have to be heliographed, raw sienna is also added to the ink, as this colour unites with it most intimately, besides intercepting the greatest amount of light.

(4) Tracing Cloth.—Varnish the cloth with Canada balsam dissolved in turpentine, to which may be added a few drops of castor oil, but do not add too much, or it will not dry. Try a little piece first with a small quantity of varnish. The kind of cloth to use is fine linen; don't let the varnish be too thick.

(5) Letterpress or illustrations printed in printers' ink may be copied by simply wetting a piece of stiff paper or card and rubbing it over with an agate burnisher or old toothbrush. If the ink has got dry through age or being kept in a hot room, moisten with spirits of wine or toilet vinegar. Have a soft blotting-pad beneath.

Pencils.—(1) Pencils made to produce marks from which copies can be obtained in an ordinary copying-press, have usually the disadvantage that, consisting mainly of aniline, the colour of the copy fades very soon. Gustav Schwanhauser overcomes this difficulty by doing away with aniline altogether. He prepares the pencils as follows:—10 lb. of the best logwood are boiled repeatedly with 100 lb. of water, and the decoction so obtained is evaporated down to 100 lb. The liquid is heated to the boiling point, and small quantities of the nitrate of oxide of chromium added, till the bronze-coloured precipitate formed at first is redissolved in a deep dark-blue colour. The liquid is now evaporated to the consistency of a syrup, and the finest levigated fat clay is added in the proportion of 1 part of clay for every 3 or 3½ parts of the extract. To form a good mass to manipulate, a little mucilage of gum tragacanth may be used. The quantity of nitrate of chromium must be in the right proportion to the extract, as a surplus prevents an easy writing, and a deficiency prevents the easy solubility of the mass for copying purposes. No other salt of chromium will answer the purpose, as they all crystallize, and the crystals formed in the mass will cause the pencil to be rough and brittle. Nitrate of chromium does not crystallize; its combination with the extract of logwood is the most easily soluble and the blackest ink. The nitrate is prepared as follows:—20 lb. of chrome-alum are dissolved in 200 lb. of boiling water. To the solution is gradually added a solution of carbonate of sodium of the same strength, till all the hydrated oxide of chromium has been precipitated. After subsidence of the precipitate, the supernatant liquid is decanted, and the precipitate is washed with distilled water, till the filtrate does not contain any more traces of sulphate of potassium and sodium, as may be shown by the addition of a little solution of chloride of barium. To the precipitate collected on the filter are successively added small portions of heated pure nitric acid, previously diluted by its own volume of distilled water, in such quantity that on boiling, a small quantity of the hydrated oxide remains undissolved. In this way a perfectly saturated solution of nitrated oxide of chromium is obtained, containing no excess of nitric acid. This is a great advantage, since an addition of nitric acid to the ink changes its colour to a muddy red. Another advantage is that no basic nitrate is formed, and no excess of hydrated oxide is contained in the produced salt, as is the case in most other salts of chromium. Such basic salts form an insoluble compound with the extract of logwood, instead of entering into solution. The writing furnished by these pencils is easily transferable; it is of a penetrating jet-black colour. Alkalies and acids have no effect on the ink. (*Schweizerisches Gewerbeblatt.*)

(2) Faber's pencil for copying writing or designs is made of different degrees of hardness, and is stated by the inventor to combine all the advantages of the very best lead pencils. Four kinds are manufactured. No. 1, very soft; composed of 50 parts of aniline, 37·5 graphite, and 12·5 kaolin. No. 2, soft; 46 parts aniline, 34 graphite, 24 kaolin. No. 3, hard; 30 parts aniline, 30 graphite, 40 kaolin. No. 4, very hard; 25 parts aniline, 25 graphite, 50 kaolin. These materials are pounded and mixed with the greatest care, and afterwards made into a paste with cold water. After the paste has been well worked and rendered perfectly homogeneous, it is passed through a wire screen, which divides it into strips of suitable dimensions. These are dried in an ordinary room, and afterwards fitted and glued into wooden cases like common lead pencils. The new pencils may be used like ordinary copying pencils for the reproduction of writing or designs. A sheet of thin paper wetted is laid over the sheet to be copied, and the details are gone over with the copying pencil. The action of the moisture on the aniline in the pencil gives a deep tint to the tracing, resembling that of ordinary writing-ink.

(3) Jacobson of Berlin has a copying pencil which is said to be composed of graphite and some aniline colour, mixed by a peculiar process. On any ordinary paper, dry, the pencil gives a sharp, well defined mark, which cannot be obliterated with indiarubber without damaging the paper, and when wetted or left to absorb sufficient moisture from the air, assumes the appearance of ink. To well-damped sheets laid over, a very slight pressure will transfer a succession of clearly defined impressions, which never blur, and have all the appearance of ink. If the original has been wetted some days before, the transfer is not made so easily. It is then found best to soak the transfer sheets in vinegar in place of water. The pencil may be used on oiled paper.

Transferring.—(1) Pixis Process for Transferring Photographs to Wood.—A phototype plate, representing the picture that is to be transferred, or its negative, is produced: it must be of the same size as the copy is to appear. The printing-ink used in the phototype process, to which any tone of colour may be given, is carefully mixed with a siccative, Japanese gold size being preferred. The quantity to be taken of this liquid depends on the question whether the picture is to dry rapidly or slowly. As a rule, 15 to 18 drops of Japanese gold size to each $\frac{1}{2}$ cub. in. of printing-ink may be considered adequate for producing that indelibility which must be attained in most cases. The photographic picture, after having been rolled over with this preparation, is transferred upon the material either directly or by means of transfer paper. The transfer upon ebony or upon any other dark material takes place by means of a white colour prepared in the above manner or of any desired light colour. But the negative required for producing the phototype plate must in this case be converted into a positive, which may be done by the gelatine process. A thin white paper, one side of which has been prepared with an entirely smooth layer of paste and well pulverised chalk, or in some instances only with a thin layer of paste, must, in dry condition, be so placed upon the phototype plate carefully impregnated with the above ink composition, that its prepared pasted side lies underneath; the paper is then softly pressed with a damp sponge, whereupon the whole is drawn through a press, if possible but a single time. The paper to which the picture has thus completely been transferred is then carefully taken off the plate, and can be immediately transferred on other materials, or it may be kept for the purpose of being transferred at a future time. In order to keep it damp for the latter purpose, it must be placed between damp blotting paper and hermetically packed up. The object to be printed must be fastened in the press, and the transfer paper, after having been moistened from the reverse, is laid on that part on which the picture is to appear. Some sheets of damp blotting paper are then placed upon the transfer paper, and the whole, together with the usual cover, is drawn through the press once or several times, according to the object upon which the transfer is being made; this done, the transfer paper is moistened with a sponge dipped in cold water until it can easily be detached from the transferred picture without leaving on it any traces of the printing ink. In order to render the picture completely clear, the layer of chalk attaching to it directly after the act of printing must be removed by means of a soft sponge which has been wetted in cold water. Boxwood blocks are prepared for the process in the following manner:—A quantity of flake white ground in oil, such as is used by painters, must be mixed with a few drops of Japanese gold size, and as much benzine added as will make it possible to work the whole in the thinnest quantity attainable and very swiftly by using a broad brush. When the wood-engraver has finished his task, he removes the white with turpentine or spirit. Upon smaller objects, such as medallions in ivory, metal, wood, &c., the transfer, if executed without delay, can be performed directly from the paper by using a smoothing-bone. This fact is important with regard to all such objects as are not quite flat but somewhat vaulted. In order to transfer a picture on porcelain, clay, or glass, Pixis takes exclusively enamel colours, and gets them upon the phototype plate by rolling. If the tone of the picture is to be lowered or strengthened, or if a variety in colouring is desired, either the phototype plate, the transfer or the material, is powdered over with dry colours of the required tint before the enamelling takes place and while the pictures are still damp. This powdering with dry colours may also be applied to pictures which are to be transferred to leather, textile fabrics, metals, wood, minerals, &c. The above-named materials, as likewise painted canvas, wood, metal, &c., may also, after the picture has been passed over, and before the transfer takes place, be prepared in the desired colour by means of oil, distemper, wax, porcelain, and water colours. Every picture, if transferred in the described manner upon wood in several colours or one colour, may, when sufficiently dried, be polished, oiled, and otherwise treated without becoming damaged. Pictures transferred on textile fabrics can be made to stand washing by drawing them, when dry, through a solution of glaire, squeezing and heating them to a temperature of 230° to 270° F. (110° to 120° C.).

(2) Take a piece of wood, such as lime, pine, or fir, and get a good, smooth surface on it by planing, glass-papering, &c., being very careful not to leave any woolliness or scratches on its surface after using the sandpaper. The next thing to do is to polish the surface well with ordinary white French polish; but do not finish off with spirits, and be sure and have a good coat of polish on. Now take the picture and lay it on the wood, with picture side to the polish; then take a piece of sponge or cotton wool, and dip it into methylated spirits; brush the back of the paper over with this, being sure it is well saturated, and that there are no air-bubbles left under

it. Now put it aside for a time until all the spirit has evaporated and the paper is quite dry, when it will be found to be securely fastened to the wood. Now, to get rid of the paper, it must be gradually rubbed away with water, using the tips of the fingers or a piece of soft indiarubber, until the picture appears equally distinct over the whole surface, when the rubbing down is to be discontinued. Now put it aside again for 4 or 5 hours until all the water has evaporated, and then polish with the white French polish in the usual way, as if you were polishing a piece of wood. The white French polish is made from white shellac and methylated spirit.

(3) Transferring Engravings to Paper.—The liquid used for this purpose may be made by dissolving $1\frac{1}{2}$ dr. common yellow soap in 1 pint hot water, adding, when nearly cool, $\frac{3}{4}$ fl. oz. spirit of turpentine, and shaking thoroughly together. Apply the fluid liberally to the surface of the engraving, or other printed matter, with a soft brush or sponge (being careful not to smear the ink, which soon becomes softened), and allow it to soak for a few minutes; then well damp the plain paper on which the transfer is to be made, place it upon the engraving, and subject the whole to moderate pressure for about one minute. On separating them, a reversed transfer will be found on the paper. This transfer will not be equal in intensity to the original, as only a part of the printer's ink is removed. If the print be very old, a longer soaking and more pressure may be necessary.

(4) Henoque's Transfer Process on Glass.—Dr. Henoque's method of transferring outlines obtained by means of a stylus on blackened paper on glass is frequently employed, only the outlines are generally executed on paper rolled on cylinders. To photograph these designs, or project them on a screen, it is usual to transfer them to glass without any alteration, the transparency of which renders it capable of being used in either way. Dr. Henoque, after removing the blackened sheet from the cylinder round which it has been rolled, spreads it on a glass, and coats the smoked surface with castor-oil collodion. As soon as the collodion is set, the plate is plunged into water, and, after a moment, a floating pellicle of collodion rises to the surface, bearing the film or smoke and the traced outline. It is next transferred to glass by means of a sheet of paper, and made to adhere with gum applied all over the plate. Great precaution must be taken to fix the edges of the pellicle by strips of paper gummed. When dry, it forms a perfect negative, or may be used as a transparency to project on a screen. In the same way, as Poitevin has indicated, chalk drawings may be removed from paper and transferred to glass. The paper for smoking should be albuminized and lightly gummed. To smoke glasses on which lines are to be traced with a point, they may be coated with lamp-black paint, and the blackened surface afterwards passed over a petroleum lamp flame. The smoke covers over all the inequalities of the coat of paint, and the design may be immediately traced. It can also be taken off and transferred to another glass in the way already indicated. (*Photo. News.*)

DISINFECTANTS. — A true disinfectant should be at once a deodoriser (destroyer of odours) and an antiseptic (destroyer of low forms of life). The presence of sewage gas in an apartment may be detected in the following way:—Saturate unglazed paper with a solution of 1 oz. pure lead acetate in $\frac{1}{2}$ pint rain-water; let it partially dry, then expose in the room suspected of containing sewer gas. The presence of the latter in any considerable quantity soon blackens the test-paper.

The Imperial Board of Health of Berlin have recently published the experiments made by Dr. Koch, with a view to establishing the true value of a number of reputed disinfectants, of which the following is a brief summary:—

1. Most surgeons have been satisfied to wash their hands and clean instruments with a 2 per cent. solution of carbolic acid: such a solution is almost

inert, and a 5 per cent. solution is necessary for the purpose. Carbolic acid dissolved in oil or alcohol proves to be totally inert, and has not the slightest effect on the vitality of micrococci or bacilli.

2. Sulphurous acid was found to be powerless against spores; bacilli and micrococci, when exposed to the fumes in a box, were killed within 20 minutes, but were very little influenced, or not at all, when exposed to the fumes in a room at the usual temperature.

3. Chloride of zinc showed itself just as harmless. A 5 per cent. solution exerted absolutely no influence on the spores of anthrax, notwithstanding the same had been exposed to the action of the remedy for a period of 30 days.

4. The spores of the bacilli were killed by chlorine water fresh prepared, 2 per cent. bromine water, 1 per cent. aqueous solution of corrosive sublimate, 5 per cent. solution of permanganate of potassium, 1 per cent. osmic acid, within 1 day; formic acid, 4 days; oil of turpentine, 5 days; solution of chloride of iron, 4 days; 1 per cent. arsenious acid, 1 per cent. quinine (water with muriatic acid), 2 per cent. muriatic acid, within 10 days; ether, within 30 days.

5. Inert or possessing very little influence: distilled water, alcohol, glycerine, oil, carbon bisulphide, chloloroform, benzol, petroleum-ether, ammonia, concentrated solution of common salt, bromide and iodide of potassium, 1 per cent. sulphuric acid, sulphate of zinc and copper, alum, 1 per cent. permanganate of potash, chromic acid, the chromates and bichromates, chlorate of potash (5 per cent.), boracic acid (5 per cent.), acetic acid (5 per cent.), tannic acid (5 per cent.), benzoate of sodium (5 per cent.), quinine (2 per cent. in water 40, alcohol 60), iodine (1 per cent. in alcohol), thymol (5 per cent. in alcohol), salicylic acid (1 per cent. in alcohol, 2 per cent. in oil).

6. As regards remedies which prevent the further development of spores, the following results were obtained. The first number means retarding the development, the rest totally preventing it:—

Corrosive sublimate	1 : 1,600,000	1 : 320,000
Oil of mustard ..	1 : 330,000	1 : 33,000
Arsenite of potash	1 : 100,000	1 : 10,000
Thymol	1 : 80,000	
Oil of turpentine ..	1 : 75,000	
Hydrocyanic acid	1 : 40,000	1 : 8,000
Oil of peppermint	1 : 33,000	
Chromic acid ..	1 : 10,000	1 : 5,000
Picric acid	1 : 10,000	1 : 5,000
Iodine	1 : 5,000	
Salicylic acid ..	1 : 3,300	1 : 1,500
Permang. of potash	1 : 3,000	
Muriatic acid ..	1 : 2,500	1 : 1,700
Camphor	1 : 2,500	
Eucalyptol	1 : 2,500	
Benzoic acid.. ..	1 : 2,000	
Borax	1 : 2,000	1 : 700
Carbolic acid.. ..	1 : 1,250	1 : 300

But as, for purposes of disinfection, the micro-organism must be killed, and in the shortest possible period, and the effect of retarding the development of the spores (antiseptic) is not sufficient, only the following remedies can, according to Koch's experiments, be said to be of value: corrosive sublimate, chlorine, bromine, iodine. Bromine in form of vapour is, as concerns rapidity of action, superior to chlorine and iodine. (*Medical and Surgical Reporter.*)

In a pamphlet recently published by Dr. John Dougall, of Glasgow,* containing an account of a series of experiments upon putrefiers and antiseptics, are some important facts which bear upon the real value of certain disinfectants held in esteem by the public. Dr. Dougall's experiments were made to ascertain (1) whether putrefaction can be accelerated by adding certain chemicals to fresh organic fluids; (2) the relative antiseptic powers of different bodies, as evinced by their preventing the appearance of fungi and animalculæ in organic fluids with which they are mixed; and (3) the relative aërial antiseptic powers of different volatile bodies, as evinced by their preventing the appearance of fungi and animalculæ in organic fluids exposed to their vapours, and by their action on vaccine lymph. Solutions of soda, potash, ammonia, and their salts, were added to solutions of beef-juice and hay infusion, as were also solutions of pepsine, lime, spirits of nitric ether, acetone, acetate of morphia, sugar, sulphate of magnesium, charcoal. Simple solutions of beef-juice were experimented upon at the same time. The results obtained show that the alkalies and alkaline earths, and their alkaline and neutral salts, with a very few exceptions, hasten decomposition when present in small proportion in fluids containing organic matter. Hence it follows that all domestic soap-suds, spent lye from soap, bleach, and alkali works, and all liquors more or less alkaline, will hasten the putrefaction of organic matters in sewage; all the chemical solutions experimented with appear to hasten putrefaction, except ammonia, permanganate of potash, and biborate of sodium, but these do not seem to retard it. Soda, potash, nitrate and chlorate of potassium, and lime, appearing specially vigorous as putrefiers at the outset of the experiment, Dr. Dougall infers that they will continue so throughout. It will be observed that salt, saltpetre, and sugar, substances which preserve meat when used in large quantities, act as putrefiers when added in small quantities to solutions containing organic matter.

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* 'On Putrefiers and Antiseptics.' By John Dougall, M.D., Medical Officer of Health for the Burgh of Kinning Park, Glasgow.

In the experiments made to ascertain the antiseptic powers of different substances, solutions of which were mixed with solutions of beef-juice, egg-albumen, and of these mingled with urine, mercuric chloride, argentric nitrate, and benzoic acid (1 in 500) alone prevented the appearance of animalculæ or fungi in the solution of beef-juice, no change being found in 182 days; they exercised the same influence on the solution of egg-albumen, as did also in addition chromic acid, cupric sulphate, and potassic dichromate, for a like period of 182 days. Chromic acid, cupric sulphate, mercuric chloride, and benzoic acid alone prevented the appearance of both animalculæ and fungi in the mixture of beef-juice, egg-albumen, and urine. On the other hand, animalculæ and fungi appeared in the different solutions, when treated with chloride of zinc, in 4 to 18 days; with carbolic acid, in 12 to 50 days; with sulphate of iron, in 4 to 40 days; with sulphurous acid, in 4 to 24 days; with chloride of lime, in 24 to 40 days; with chloralum, in 2 to 11 days; the time seeming to vary in an irregular manner with the different substances when applied to different solutions. Dr. Dougall considers that his experiments prove that putrefaction and fermentation are not identical processes; that putrefaction is more difficult to prevent than fermentation; that fermentation frequently subsides into putrefaction, but that the latter is seldom intensified into the former. The best antiseptics are acids, for it is apparently impossible for marked putridity and acidity to go together; and we mentioned above the only substances which, preventing putrefaction, also prevented fermentation.

The next portion of Dr. Dougall's pamphlet deals with the far more important branch of his subject — the relative aërial antiseptic powers of different volatile bodies; in other words, the power of purifying an atmosphere contaminated with zymotic virus or emanations found in hospital wards. The substances experimented on—putrescents—were milk, beef-juice, urine, egg-albumen, hay solution, and a mixture of all five. 4 dr. of each were placed on a stand 6 in. high, at the bottom of which was an ordinary saucer filled with the supposed antiseptic. The whole was covered with a bell-jar of 1 cub. ft. capacity, so that the roof was 6 in. above the putrescent. The antiseptic was put under the jar 12 hours previous to submitting the substances to its vapour. The "smoking" was continued for 6 days, unless fungi or microzymes appeared, and afterwards the substances unaffected were exposed to ordinary air for 12 days. All the solutions, when merely exposed to the air, contained either fungi or animalculæ after the lapse of 12 hours (hay) to 4 days (milk). Carbolic acd prevented the appearance of eitheri in milk, beef-juice, urine, and egg-albumen; but in the hay solution and in the "mixture," animalculæ and fungi appeared in 2 to 3 days, with an "abundance of vertical bacteria in 12 hours," and in 48 hours abundance of free life. Chloroform, camphor, sulphuric ether, all failed to prevent the appearance of either fungi or animalculæ, or both; but no putrefaction or fermentation took place in the solutions submitted to iodine, glacial acetic acid, and hydrochloric acid. Chloride of lime acted as an aërial antiseptic to all the substances except beef-juice, which exhibited animalculæ on the 15th day, and *Penicillia* and *Torulæ* on the 11th. With sulphurous acid, *Penicillium* appeared on the 15th day in the beef-juice and the hay solution; and animalculæ appeared in 15 days in the hay solution submitted to nitrous acid. The results of these experiments show that camphor and sulphuric ether favour putrefaction, that chloroform is inert, but that carbolic acid, sulphurous acid, and chloride of lime are all aërial antiseptics, the latter the best of the three; and that nitrous acid, glacial acetic acid, and hydrochloric acid are the most perfect in their action, the last two being equal and best. Dr. Dougall says: "As the conditions of the experiments infinitely surpassed in severity any produced by their practical application, and seeing that withal putrefaction and fermentation were not entirely prevented, hence aërial antiseption or disinfection in the great majority of cases is fallacious."

Along with the putrescents, and exposed to the different vapours, were separate minims of vaccine lymph, which were afterwards used to vaccinate children, and the summary of results shows that carbolic acid, both vapour and solution, failed to affect the vitality of the vaccine virus, in common with chloroform, camphor, sulphuric ether, and iodine. The vaccinations attempted with the lymph which had been subjected to the action of the vapour of chloride of lime, sulphurous, nitrous, glacial acetic, and hydrochloric acids, were, however, all unsuccessful. "Hence," says Dr. Dougall, "volatile acids, or a volatile body causing acidity by chemical affinity, as the chlorine from chloride of lime, which produces hydrochloric acid and free oxygen, are the best destructives of the active properties of vaccine lymph, and therefore, *à priori*, of variolous matter, and the other zymotica." This, be it observed, is not altogether unexpected: it has been frequently asserted that carbolic acid does not destroy effluvia, but removes them or occludes them for a time. But here we have a minim of vaccine lymph buried in 1 cub. ft. of carbolic vapour for 36 hours, and yet it is unaffected; what effect, then, will its vapour have on the contagium of the zymotics as applied in ordinary domestic or hospital use? Some experiments by Dr. Cameron, of Dublin, made with ivory points charged with lymph and exposed to the vapour of chloride of lime, confirm those of Dougall; and Dr. Cameron says: "If the ordinary gaseous disinfection sometimes fails to destroy the vitality of vaccine, and has no effect on microzymes, we cannot rely on it as a means of destroying the contagiums of zymotic diseases, which certainly are near akin, if not to bacteria, at least to the virus of vaccine." (*English Mechanic.*)

A paper by Surgeon-Major O'Neil, in the Army Medical Department's Report for 1871, gives the results of experiments as to the relative power of some reputed antiseptic agents. In all the experiments, animalculæ having distinct, however feeble motion, were observed on the 2nd day. Chloralum, chloride of aluminium, and chloride of zinc are set down as of little practical value. Permanganate of potassium was found to have considerable power as a deodorant, but hardly any as a germicide. With sulphate of copper, animalculæ became abundant on the 16th day, when there were 4 parts of organic matter; and smell was noted on the 21st day, when there were 12 parts. Bisulphite of sodium was ascertained to be of no value. Employing carbolic acid, animalculæ became abundant on the 10th day, when there were 8 parts of organic matter, and not till the 23rd, when there were 6 parts. Bichromate of potassium was tried up to 30 parts of organic matter, and was under observation for 30 days, and resisted up to this point. "This," adds the report, "is the most powerful of all the agents tried. It appears quite equal to carbolic acid in preventing the development of the fungi, and much superior to it and all the others in limiting—none of them prevent altogether—the development of animalculæ. It is also by far the most powerful as a deodorant.

Professor Beilstein, who has recently studied the various substances used for disinfection, arrives, in a communication made to the St. Petersburg Technical Society, at the following conclusions:—Sulphuric acid would be the best disinfectant if it did not destroy the sides of the tanks; the use of lime and salts of lime ought to be completely renounced, as they but temporarily destroy bacteria, and under some circumstances may contribute to their development; nor does sulphate of iron, even in a solution of 15 per cent., ultimately destroy bacteria, as they revive when put into a convenient medium. Therefore, Professor Beilstein recommends sulphate of aluminium, which is used in paper and printed cotton manufactures. The best means for providing it is to make a mixture of red clay with 4 per cent. of sulphuric acid, and to add to this mixture some carbolic acid for destroying the smell of the matter which is to be disinfected.

In the United States, paper impregnated with carbolic acid is used to wrap up meat sent to a distance, and protect it from the influence of the atmosphere. It is prepared by melting 5 parts stearine, in which 2 of carbolic acid are well stirred; 5 parts paraffin are then added to the mixture. The whole is stirred as it cools, and applied on the paper with a brush.

Professor Carlo Pavesi, of Italy, proposes as an improved disinfectant a solution composed of chloride of lime, camphor, and glycerine. This mixture is capable of being used in all cases in which carbolic acid is now employed, and its odour is less disagreeable, less irritating, and less toxic than that of the latter. It is said at once to arrest the putrefaction of animal bodies, and is highly commended by the *London Medical Record*.

A commission of the French Academy report that nitric oxide is a most potent disinfectant, being greatly superior to every other substance as regards its action on infectious germs. The gas is applied by mixing in a 2-gallon stoneware vessel 2 qt. water, 3¼ lb. ordinary commercial nitric acid, and ½ lb. copper turnings. The gas thus evolved is sufficient to disinfect a room containing 30 to 40 cub. yd.; the crevices in the doors and windows should be covered over with gummed paper to avoid loss of fumes, and their injurious action on the health; when 48 hours have elapsed, the doors are unsealed by a man protected by a suitable respirator, and the room is well ventilated.

Dougall finds that in power of coagulating albuminous substances, and hence preventing decomposition and germ growth, chromic acid is far superior to phenol; the comparative coagulating power of various antiseptics was found to be—

Chromic acid	1
Phenol (carbolic acid) . .	$\frac{1}{16}$
Nitric acid	$\frac{1}{13}$
Corrosive sublimate . . .	$\frac{1}{20}$
Chloralum	$\frac{1}{130}$

&c. &c.

As a preventive of germ life, chromic acid exceeds phenol in nearly the same proportion. The power possessed by chromic acid of coagulating albumen, gelatine, &c., &c., renders these substances the best antidote that can be given in case of poisoning by chromic acid.

The employment of thymol as a substitute for carbolic acid in surgical dressings is a natural consequence of the discovery of its greater antiseptic and less septic power. A lecture on the subject has been published in Volkmann's series by H. Ranke, of Halle. The solution used, instead of the 3 per cent. solution of carbolic acid, consists of 1 part thymol, 10 of alcohol, 20 of glycerine, and 1000 water, and can be employed as either a spray or a solution. An impregnated gauze is also used. Since thymol does not irritate the wound, the gauze may be laid directly upon it—otherwise the same method is employed as in Lister's plan. If the gauze becomes hard and dry, it may be moistened once or twice a day with thymol water. In order to prevent the evaporation of the thymol from the dressing, the gauze is covered with oiled paper. From an experience of 41 wounds dressed with thymol, the lecturer concluded that the method leaves nothing to be desired as to its antiseptic effect, and that it answers better than the carbolic acid dressing, since the secretion from the wound is less, the period of healing shorter, and the cost of the dressings is smaller. Further, it has no poisonous properties, and eczema was never observed in its use. (*Lancet.*)

The following methods for smallpox disinfection are ordered by the Illinois State Board of Health. The best disinfectants are sunlight, fresh air, soap and water, thorough cleanliness, for general use. For special purposes the following are the most efficient, the simplest and the cheapest:—1. *Copperas disinfectant.*—Sulphate of iron (copperas), ½ lb.; water, 1 gal. A convenient way to prepare this is to suspend a basket containing about 60 lb. copperas in a barrel of water. The solution should be frequently and liberally used in cellars, privies, water-closets, gutters, sewers, cesspools, yards, stables, &c. 2. *Sulphur disinfectants.*—Roll sulphur (brimstone), 2 lb. to a room 10 ft. square, and in the same proportion for larger rooms. When using this, have all windows, fire-places, flues, key-holes, doors, and other openings securely closed by strips or sheets of paper pasted over them. Then place on the hearth or stove, or on bricks set in a wash-tub containing live coals, some sulphur. All articles that cannot be burned, on account of their value, must be left in the room; while this fumigation must last for 24 hours, and may be repeated, when the doors and windows should be left open for 2 or 3 weeks. 3. *Zinc disinfectants.*—Sulphate of zinc (white vitriol), 1½ lb.; common salt, ¼ lb.; water, 6 gal. Into this solution all clothing, blankets, sheets, towels, &c., should be dropped immediately after use, and should be well boiled as soon as practicable. Into this solution ought to be dipped the outer wrap of any visitor when he leaves the room. In the event of death the body should be wrapped in a sheet thoroughly saturated with this solution. 4. *Thymol water.*—Made by adding 1 teaspoonful spirits of thymol to ½ gal. water. Spirits of thymol is composed of 1 oz. thymol, 3 oz. alcohol 85 per cent. This may be used for the same disinfecting purposes as carbolic acid; it is quite as efficient, and has an agreeable odour. When thymol is not available, chloride of zinc solution may be used: ½ oz. chloride of zinc to 1 gal. water. (*National Board of Health Bulletin.*)

Richardson impregnates filter paper with iodine by pouring over it a solution of iodine in amyl hydride. The volatile solvent almost immediately evaporates, leaving the paper charged with iodine. A few such sheets hung up in a sick room in various places cause the air to become slightly charged with iodine vapour, whereby disinfection is rapidly effected. If a higher charge be required, it may be obtained by burning a few papers after the fashion of spills. For highly infectious cases, where more rapid action is required, the solution of iodine in amyl hydride is disseminated through the room in the form of spray, a glass spray-producer being employed, as metal would be rapidly corroded. If much solution has been used, care must be taken not to bring a light into the room, as the mixture of air and amyl hydride vapour is explosive in certain proportions. In obstinate cases—where a strong persistent smell is to be got rid of, for instance—the room must be closed up for some time after filling it with spray, in order to give the iodine time to act on the noxious matters. (*Medical Times and Gazette.*)

Eckstein finds that bleaching-powder is the most effective disinfectant for privies, urinals, &c., inasmuch as it rapidly decomposes hydrogen compounds, such as ammonia, sulphuretted hydrogen, &c. It is conveniently applied in a bag made of parchment paper, through which the disinfectant slowly passes by osmosis. Comparative experiments made in the author's house (where at least 100 persons use the closets daily) gave the following results:—

(1) 2 lb. sulphate of iron (green vitriol) dissolved in water prevented the production of smell for 2 or 3 hours, and had wholly lost its preservative action in 12 hours.

(2) Sulphate of copper in solution produced the same result.

(3) 2 lb. solid sulphate of iron or sulphate of copper acted as a disinfectant for full two days.

(4) A mixture of iron and copper sulphates and carbolate of lime (2 lb. in all) only remained active for 2 days.

(5) Solution of sulphurous acid lost its action quickly: it was perceptible to the respiratory organs for an hour.

(6) Crude carbolic acid filled the house with a peculiar tarry odour for 2 days. This was so powerful that it could not be determined whether the smell of the fæcal matter was decomposed or merely hidden by a more powerful odour.

(7) 2 lb. sulphate of iron in a parchment-paper bag only became active after 2 hours, and remained active for full 3 days, at the end of which time the bag contained a muddy liquor destitute of smell.

(8) 2 lb. good commercial bleaching powder in a parchment-paper bag became active in 2 hours, and remained efficacious for full 9 days, without in the least affecting respiration or smell.

(9) Crude permanganate of soda disinfected immediately, but only lasted for 1 day. In a parchment-paper bag the same quantity lasted 2 days.

From these results the author concludes that bleaching-powder in a parchment-paper bag acts the longest and the most energetically, and is therefore the best disinfectant of those tried.

The merits of sulphate of iron (copperas or green vitriol) for disinfecting purposes have been described thus:—It is not a hygienic disinfectant, since it does not destroy the lower forms of life. As a remedy, therefore, against the spread of epidemic diseases, which spread by the dissemination of the germs of such minute organisms, it is quite useless. As a chemical disinfectant, however, for the suppression of offensive odours, affecting the question of comfort rather than health, it is an excellent agent. Wherever the ordinary system of a walled reservoir for holding excremental matters is in vogue, and where, as is generally the case, the reservoir is but seldom emptied, the air of the vicinity, especially during periods of low barometer, will be charged with pungent and offensive odours. These may be effectually checked by the periodical addition of the sulphate in solution in water.

Valmagini of Vienna alleges that binoxide of manganese is a valuable and potent disinfectant. He has found that ozone is not only present in this mineral, but that it is continually regenerated. Hence he considers the mineral well adapted for destroying putrefactive gases.

Lead chloride is declared to be an excellent disinfectant, absorbing and neutralizing various organic vapours. It may be prepared by precipitating 65 oz. lead nitrate with 23⅖ oz. sodium chloride, yielding 55⅗ oz. dry lead chloride. It is very slightly soluble in cold water, 1 gal. not holding more than ¼ oz.; hot water dissolves more, but the salt crystallizes out again on cooling. For closets, ½ lb. of the salt may be suspended in 1 gal. water, but it is better hot.

Certain inconveniences and disadvantages attending the use of carbolic acid spray in dressing wounds have led to a general search for acceptable substitutes.

One of the most promising is the use of substances which are volatile as well as of antiseptic nature, such as eucalyptol, cajeput, terebene, and peppermint, by means of which a wound may be kept, if necessary, in an antiseptic atmosphere, not merely while being dressed, but at all times. At the late annual meeting of the British Medical Association, A. W. Mayo Robson described a series of experiments made by him to test the efficiency of atmospheres charged with such volatile antiseptics in preventing the development of life in putrescible fluids, the results being exceedingly encouraging. Flasks of sterilized hay infusion suspended in large wide-mouthed open jars, into which a little eucalyptus oil, cajeput oil, or the like, had been poured, remained clear; while flasks of the same infusion, briefly exposed to ordinary air and then covered with cotton wool, began to lose clearness and to scum over within a few hours. Altogether the results were thought to indicate that at ordinary temperatures air saturated with vapours of the class named was fatal to the germs of bacteria and micrococci, and probably also to the germs of fevers and other infectious diseases. As the vapours tested are not unpleasant or injurious when breathed, it is to be hoped that practical tests in hospital wards will confirm the promise of Robson's experiments. As eucalyptol—derived from the common eucalyptus—is abundant and cheap, it has been selected for further tests. When the vapour is used during surgical operations, a bellows is employed to discharge air charged with it upon the spot exposed. The air is first drawn through a vessel filled with cotton wool, then through others filled with pumice, over which a small quantity of eucalyptol has been poured. The emerging air is thus loaded with invisible particles of the antiseptic, which seems to be capable of destroying any vestiges of germ-life which may have been drawn in from the surrounding atmosphere. This is a pleasanter method than Lister's, or the boroglyceride treatment of Professor Barff.

Not less promising is the turf-mould dressing of Dr. Neuber, of Kiel, the result of investigations of the antiseptic qualities of turf-mould made by him during the past two years. The fibrous and friable character of turf, and its lightness, softness, and elasticity, make this substance much neater and more comfortable than "dry earth" as a surgical dressing; and it seems also to have much greater antiseptic power. The mould, reduced to powder, is enclosed in bags of carbolised gauze, and simply bound upon the wound, which has previously been washed with a carbolic or other antiseptic lotion. This dressing has been used by Professor Esmarch in 55 cases, most of them severe operations, with wonderfully good results. In 31 cases there was no fever, and in only 5 cases was it necessary to remove the dressing, owing to either local or general disturbance. The chief advantages claimed for this dressing are its great absorbent power, its tendency to prevent the formation of putrefactive products, the easy adaptability of the turf pads to the surfaces of the body and limbs, and its cheapness, the cost being about $\frac{1}{6}$ that of the Listerian dressings. For use in public hospitals, and in private practice among the poor, the element of economy is a very important one.

A disinfecting paint is composed of 5 to 10 parts carbolic acid, 15 manganese binoxide, 10 calcium chloride, 50 china clay, 20 infusory earth, 10 dextrine or gum-arabic.

The glyceroborates of calcium and of sodium are introduced as powerful antiseptics, soluble in water, odourless and non-poisonous. To obtain the calcium compound, calcium borate and glycerine are heated to a temperature of 320° F. (160° C.), with constant stirring, until a drop of the mixture, brought by a glass rod on to a glass plate, forms a colourless pearl. On cooling, the mixture becomes a glass-like mass, which is easily broken, and which, before it is quite cold, must be conveyed to a well-stoppered bottle. Sodium glyceroborate is prepared in the same way, anhydrous sodium borate replacing the calcium borate.

A preparation called "sinodor," for removing unpleasant odours, and disinfecting and preserving *organic* substances, is made by heating neutral magnesium acetate with magnesium oxide until the formation of hydrate is complete. The mass should assume a slimy appearance. It consists of basic magnesium acetate, containing an excess of magnesium hydrate.

It has often been noticed that the addition of bleaching powder to carbolic acid in dressing wounds causes healing to take place more rapidly than when the acid is used alone. It has been shown by *Diamin* that phenol and bleaching-powder react on one another, forming mono-, di-, and tri-chlorophenol, which may be isolated and separated by treatment with a strong acid and distillation with aqueous vapour. C. O. *Cech*, considering that these chlorophenols are probably formed when carbolic acid and bleaching-powder are used together in dressing a wound, and exert a healing power greater than that of carbolic acid alone, attempted to prepare chlorophenols in quantity by the above process; it proved dangerous on the large scale, and direct treatment of phenol by chlorine gas was resorted to. A red crystalline mass was produced, from which white crystals are obtainable by pressure between filter-paper; after purifying these crystals by precipitation from their alcoholic solution by water, they were dissolved in alcohol, and the bandages were impregnated with this solution. These crystals consist of a mixture of three chlorophenols, in which trichlorophenol predominates, and is probably the most useful. The chlorophenols present the advantage over phenol of being less corrosive and poisonous, and trichlorophenol probably has most advantage in these respects; its value as a disinfectant remains to be decided by the use of the chlorophenol bandages. (*Pharm. Jl.*)

A large amount of the quackery and confusion which prevail in the prescription and use of disinfectants is due to ignorance of the precise nature of the contagia of diseases which disinfectants are intended to destroy or render inert. Disinfectants, deodorants, and antiseptics have been confounded, because so long as the nature of the noxious material was unknown, the chemical agents were selected to satisfy the most various and differing theories as to its nature and properties. Recently a flood of light has been thrown upon the nature of the contagia of many diseases, and being acquainted with their life history, we can select appropriate disinfectants. These propagating agents consist of minute solid particles, probably of a vegetable nature, and appear as a corkscrew-like spirilla in relapsing fever and as a large motionless rod (*Bacillus anthracis*) in wool-sorters' disease; while in fowl cholera the blood is purpled with a micrococcus $\frac{1}{30000}$ in. diameter. When these organisms exist in clothing, they can be destroyed by dry heat (220° F. for 2 hours), or by thorough boiling and washing. Some kinds, at all events, multiply in media external to the animal body, and this multiplication appears in many cases to be favoured by diet. Being non-gaseous, they are not withdrawn from air in which they may be floating in clouds by liquid or solid disinfectants exposed in vessels, and in these circumstances should be expelled by ventilation or cleansing, or attacked by gaseous disinfectants. Experiments upon vaccine matter, which may be taken as the type of a virulent material, show that disinfectants to be effectual must be used in much larger quantity than is usually considered necessary, and that when the disinfectant is of an acid nature, the virus must be rendered permanently and strongly acid. These experiments show that sulphurous acid is much more potent than chlorine as a gaseous disinfectant, and that though carbolic acid, in quantity equal to 2 per cent. of the virus, completely deprives it of its infective power for the time being, yet it is not permanently abolished, but returns when the carbolic acid has escaped through exposure to the air. Permanganate of potash, though deficient in antiseptic properties, is truly disinfectant when used in such quantities that the colour is retained, but the expense becomes enormous, except for a few purposes. Though we have no trustworthy light from direct experiment, there is reason to believe that many metallic salts in very strong solution are disinfectant, and at all events many of them are antiseptic (fatal to microzymes). The waste chlorides from the manufacture of chlorine might be used for drains. It should be remembered that agents such as carbolic acid and metallic salts, which in small quantity have a preservative power, may actually prolong the life of contagium which would otherwise succumb to natural processes if the agents are used in limited quantity. Experiments upon vaccine matter prove that several lauded and patented "antiseptics and disinfectants" are perfectly worthless so far as any useful influence upon this virus is concerned. It is necessary clearly to understand what is required when selecting an agent for practical use. There are good deodorants which arrest putrefaction and fermentation, and yet completely fail to destroy contagious particles embedded in an epithelial or albuminous envelope, as they usually are. (Dr. Russell.)

Two sets of important researches on disinfection have been lately (1879) going on at Berlin. In both the test of the efficacy of the particular disinfectant used has been the effect produced by it either in destroying bacteria and vibriones in putrid fluids exposed to its action, or in preventing their development in a form of "Pasteur's fluid," in which the objects that had undergone disinfection in various degrees were immersed.

The first experiments, those of Dr. Mehlhausen, Director of the Charité Hospital, refer chiefly to the disinfection of rooms in which scarlet fever and other infectious cases have been. The result arrived at is that the most energetic and the cheapest disinfectant is sulphurous acid. Chlorine gas has the disadvantage of destroying clothes and furniture exposed to it, while it is less easy to manipulate, and 4 or 5 times as expensive as sulphurous acid. 16 gr. sulphur per cub. yd. of space destroy, when burnt in a closed room, all bacterial life in 16 hours. Besides blocking up the doors and windows, Mehlhausen advises that the room shall be previously warmed, if the weather is cold, in order to prevent the gas finding its way into the neighbouring apartments. It is also advisable to damp the floor before lighting the sulphur, so as to profit by the great solubility of sulphurous acid in water: 8 hours is long enough to keep the room shut up after the sulphur begins to burn, and at the end of that time any clothes or bedding in it will be effectually disinfected. Mere free exposure of an infected room to the air by allowing the windows to stay open several days is not enough to disinfect it. This has been practically proved at the Charité Hospital after scarlet fever and measles in several instances. (*Medical Times and Gazette.*)

The second series of experiments was made by Dr. Wernich, of Breslau, in the chemical laboratory of the Berlin Pathological Institute, upon the disinfecting power of sulphurous acid and dry heat. The method adopted consisted in preparing an "infecting material" by steeping woollen threads, pieces of linen-rag and cotton-wool, previously proved to be free from atmospheric organisms, in putrid solutions of fæces or meat, and gently drying them. These substances were then tested for their capability of producing bacteria by the means of the modified Pasteur's fluid above mentioned, which consisted of 100 parts distilled water, 10 cane-sugar, 0·5 ammonium, and 0·1 potassium phosphate. This solution was freshly prepared before each set of experiments, filtered, boiled for ½ hour, and immediately poured into the test-glasses and preserved with the usual precautions. To test the effect of disinfection, the wool or wadding, after exposure for a definite time to a definite degree of heat in an oven, or to a measurable volume of sulphurous acid in a bell-glass, was immediately transferred to the Pasteur's fluid, and the efficacy of the disinfectant was estimated by the rapidity of development of bacteria, if such appeared, or by their complete absence, as indicated by the fluid remaining perfectly cloudless. It was thus found that 3·3 per cent. of sulphurous acid by volume failed even after many hours to prevent the development of bacteria, but that if the amount of gas reached 4·0 to 7·15 per cent. by volume of the contents of the bell-jar, and the process had gone on for at least 6 hours, no bacteria at all developed. On the other hand, while exposure to a temperature of 230° to 244° F. (110° to 118° C.), even for 24 hours, failed to destroy the bacterial germs, 5 minutes' exposure to one of 257° to 302° F. (125° to 150° C.) invariably succeeded, and the test fluid remained clear even for 11 days or longer. Dr. Wernich specially reminds us that his results must not be taken as applicable to all forms of bacteria, some of which probably require severer measures for their complete destruction. He also points out that it is easier to disinfect wool than linen, and that cotton wadding is the most difficult of all to free from infectious germs. (*Centralblatt Med. Wiss.*)

Sulphurous acid has of late years occupied a prominent place amongst disinfectants, since having been recommended by a committee of the German Empire for the cholera epidemic. Recently, however, its disinfecting power has been disputed. The Imperial Sanitary Board has therefore thought it necessary to submit this important matter to a renewed investigation. The necessary supply of sulphurous acid for disinfecting purposes is usually furnished by burning sulphur. This has, however, proved to be inefficient for several reasons. Sulphur is known not to burn very readily, and often to extinguish, and although this difficulty could be remedied by moistening it with spirit, the quantity of sulphurous acid evolved has been found to fall far short of the amount which might be produced with sufficient air supply. This is due partly to deficient ventilation, partly to a loss of gas by escape. Thus, in tightly-closed sulphurizing chambers, a larger amount of sulphurous acid than 6·5 volume per cent. cannot be obtained, and in an imperfectly closed space, as in rooms, [illegible] 40 per cent. of the available quantity of sulphur is converted into sulphurous acid gas. Experiments have been made to obtain information about the communication of the gas to the different parts of a room, and also on the subject of disinfection, with a view to find out whether, and to what extent, the disinfectant penetrates into their interior. The method which was used for both purposes, and which has been made a special study by B. Proskauer, was the absorption or oxidation of the gas in a permanganate solution acidulated with hydrochloric acid, and subsequent gravimetric determination. The application of sodium bicarbonate and titration with iodine solution has proved in all those experiments totally useless. It has thus been found that the gas in the experimenting rooms generally diffuses uniformly in all directions. Yet in a few cases, there were differences between the ceiling and the floor observed up to 3 volumes per cent. Also, the mortar of the walls had unequally absorbed some sulphurous acid. Moreover, the spreading of the gas over the objects of disinfection, as well as the penetration into their interior, was very uneven. Thin and very transmissible objects, such as letters, papers, clothes, permit the gas to enter copiously, but very little of it passes into the interior of voluminous and less permeable bodies, with a medium proportion of gas and the usual duration of the process. Thus, large commercial packages, as bales of goods and the like, cannot efficiently be sulphurized without loosening their covers and spreading out the contents. As this, however, cannot be practically carried out, sulphurous acid is not fit for the disinfection of packed goods. The same may be said with regard to dwellings and sick-rooms as well as ships. Sulphurous acid has hitherto been believed to possess the power of destroying germs of infection without in the least disintegrating the carriers of them. After the observations now made, this can no longer be admitted, [illegible] has been proved that the moistenment of the disinfecting objects, which many necessary to bring about the tion, causes them, even in a less concentrated state of the sulphurous acid, [illegible] become injured, probably by assisting the [illegible]lation. Also, experiments have been made upon various forms of fungi and other low organisms, and they have shown that sulphurous acid is capable of destroying them rapidly, if they have not yet assumed the state of permanency, and if they are lying near enough the surface to be sufficiently exposed to the gas. But to such organisms as have once passed into a permanent condition, the sulphurous gas, even in a high state of concentration, is utterly harmless, provided they are dry. It is true that by moistening them, all infectious matters become much more susceptible to the killing power of sulphurous gas. But the presence of water by no means affords absolute security, and it has been specially observed that spores arrived at the permanent state do not at all lose their capability of developing, if they are moistened and placed for 24 hours in a tightly-closed room which contains no less than 5 volumes per cent. of sulphuric acid. (G. Wolffhügel, *Chem. Cent. Blatt.*)

DYEING, STAINING, AND COLOURING.—The subject may be divided into the following sections:—

Calico-printing.—The following summary of recipes for calico printing are in the main condensed from an article on the subject, by W. Crookes, F.R.S., in Spons' 'Encyclopædia,' to which the reader may refer for greater detail and illustrations of machinery.

CHROME STANDARD—2 gal. boiling water, 8 lb. bichromate of potash. Dissolve, and add 1⅔ gal. muriatic acid at 32° Tw. Stir gradually in 3½ lb. sugar.

The pieces, before printing, are bleached in the most perfect manner. After the so-called "colours" have been printed on, the next step is "ageing." In this process, the goods are laid in bundles upon sparred floors, placed at different heights in the ageing house. The temperature is kept at 80° F. (27° C.), the wet-bulb thermometer marking 76° F. (24½° C.). The ageing process may last 2 to 3 days; its object is the decomposition of the acetates of alumina and iron in the mordants, so that either the bases or hydrated subsalts are left attached to the fibre.

The next step is "dunging," whose purpose is the removal of the thickeners, which have now played their part. The process was formerly performed with cow-dung. This material has, however, been almost entirely superseded by the double phosphate of soda and lime, the arsenite and arseniate of soda, and the silicate of soda. The pieces are passed through warm but weak solutions of these substances. This operation is often performed twice, the first time being called "fly-dunging"; and the next, "second dunging." When silicate of soda is used, the goods pass through two cisterns, heated to 122° F. (50° C.), or even 212° F. (100° C.), containing 738 gal. water and 19 gal. silicate of soda at 14° Tw., if the goods have been mordanted for brown and red, black and red, brown only, red only, and rose on a white ground. But if mordanted for black only, purple only, or purple and black, the proportion of silicate of soda is reduced to 13½ gal. at the same strength. The next step after washing is the dyeing with artificial alizarine, or anthrapurpurine. The colour is now permanently attached to the mordanted portions; but the whites are still stained or soiled, and the pieces are therefore submitted to the clearing process (*avivage*), which consists in successive treatments with soap-lye. A common treatment is two soapings at a boil, each time for ½ hour, with ¼ to ½ lb. soap. The pieces are washed in clean water after each soaping. The quality of the soap is of great importance: it should be quite neutral, and is made by preference from palm-oil. Freedom from alkalinity is especially important for madder-purples.

The following process has been employed in Alsace for clearing roses and reds:—(1) Soap bath; 2100 pints water, 9 lb. white curd soap, per 1000 yd.; time 1¼ hour; temperature, 122° F. (50° C.). (2) Washing in machine with cold water. (3) Bath of oxy-muriate of tin: 1400 pints water, 10 lb. solution of tin per 10 yd.; time, 15 to 20 minutes; temperature, 133° to 143½° F. (56° to 62° C.). (4) Washing in machine. (5) Second soap bath: 2100 pints water, 6½ soap; time 45 minutes; temperature, 201° F. (94° C.). (6) Washing again in cold water. (7) Third soap-bath: proportions as in second. (8) Washing again in cold water. (9) Boiling in closed boiler, in 2100 pints water, 5½ lb. soda crystals, 5½ lb. soap; time, 2 hours. (10) Washing in cold water. (11) Warm bath for ½ hour in water at 122° F. (50° C.).

Grass-bleaching is occasionally used in the clearing process for chintzes, cretonnes, &c., as it is considered to render the shades more transparent.

Discharge Style. — By a "discharge" *(enlevage)*, is understood a mixture which, if printed upon cloth previously dyed some uniform colour, e.g. Turkey-red, vat-blue, aniline-black, &c., destroys such ground colour, leaving a design which may be white, black, yellow, green, &c. The term "discharge style" is more especially applied to patterns of this nature obtained upon a Turkey-red. The following colours will serve as examples of these discharges:—

Black.—1 gal. logwood liquor at 4° Tw.; 2 lb. yellow prussiate; 1 qt. thick gum tragacanth water, 2 lb. flour. Boil, and add 2 qt. black liquor at 30° Tw. When quite cold, add 1 gill nitrate of iron at 80° Tw.

Blue.—5 lb. tartaric acid, 1 gal. water, 1 gal. tin pulp, 2 gal. double muriate of tin at 120° Tw., 2 gal. gum tragacanth water.

White.—(1) For cylinder work—6 lb. tartaric acid, 1 gal. water, 1½ lb. starch. (2) For block work—10 lb. tartaric acid, 7½ lb. China-clay, 1½ lb. perchloride of tin, 1 pint gum water, 1 gal. water.

Yellow.—(1) Block—1 gal. lime-juice at 50° Tw., 4 lb. tartaric acid, 4 lb. nitrate of lead. When dissolved, add 6 lb. China-clay, 3 lb. gum senegal. (2) Cylinder—Thicken the former with 1½ lb. starch, instead of gum and China-clay.

After any of these discharges is printed on, the pieces, when dry, are passed through the "decolouring vat," which is made up of 1000 gal. water and 1000 lb. chloride of lime, well raked up, and freed from lumps. A double set of wooden rollers at top and bottom is placed in the vat, and the liquid is kept constantly stirred up, so as to be uniform. The pieces are now allowed to run through the liquor at the rate of 28 yd. in 3 minutes. On leaving the vat, they are run between squeezing-rollers into water, and are then rinsed for 10 minutes in solution of bichromate of potash at 4° Tw. Wash in pure water, then in water soured with muriatic acid, and lastly in pure water; after this, dry. Except where the discharge was printed on, the Turkey-red is unaffected; but there, it is removed, and either the ground is left white, or a mineral colour takes its place.

Indigo Effects.—Under this style, will be included the so-called "China blues"—designs in blue on a white ground; the kinds where reserves or resists are printed upon the cloth, which is then dyed in the vat, thus producing white, yellow, and orange designs on a blue ground; and lastly, the style named "lapis" or "lazulite."

Direct Indigo Blues.—(1) Put into a colour pan, 8 lb. 2 oz. indigo, finely ground in water, 4 lb. 6 oz. indigo in 26 pints liquid. Heat; and add 6 lb. 9 oz. ground gum. Dissolve; and add 11 lb. saturated hydrosulphite, 15½ oz. milk of lime, containing 7 oz. lime per 1¾ pint. Heat to 158° F. (70° C.) for 20 minutes; cool down to 104° F. (40° C.); and add 3 lb. 4 oz. saturated hydrosulphite, and 15½ oz. milk of lime. The yield is 30 lb. 12. oz. of colour.

(2) Mix 22 lb. *bleu-gommé* (explained

below), 13 lb. 2 oz. gum water, 15 lb. 5 oz. saturated hydrosulphite, and 32¾ oz. milk of lime.

These colours must always be used warm, never under 80° F. (30° C.), nor over 95° F. (35° C.). Nor must they be used too soon after they are prepared. Those colours give the best results, which show a greenish hue till the next morning.

When the colours are printed, the pieces are spread out overnight in an airy place, or, if necessary, they may immediately after printing be passed through a weak lukewarm chrome beck. In either case they must be very well rinsed, washed and soaped, for 30 to 45 minutes at 122° to 140° F. (50° to 60° C.). If the whites are not good, they are taken through weak chloride of lime. If this blue is printed along with other colours, the pieces may undergo the treatment necessary for such colours, without any attention being paid to the blues. Passing through soda, sulphuric sours, chrome baths (warm or cold), alkaline, chrome and lime baths, silicate of soda, phosphates of lime or soda, cow-dung, &c., has no effect on these blues.

The *bleu gommé* is prepared as follows:—4 lb. 6 oz. good Bengal indigo are ground up in the ordinary manner, employing water enough to make the paste up to 35 pints. This placed in a boiler, made up with water to 105 to 140 pints, along with 11½ lb. caustic soda-lye at 62° Tw. and 30¾ lb. hydrosulphite of soda. It is heated to about 158° F. (70° C.) for 15 to 20 minutes. Then 131 fl. oz. hydrochloric acid are poured in through a long-necked funnel, reaching to the bottom of the vessel. This operation should be performed under a chimney, as much sulphurous gas is given off. If the liquid has a faintly acid reaction, the decomposition is complete, and the whole is poured into a cask capable of holding 280 pints, which is filled up with water. The next morning, the liquid standing over the sediment is run off through holes in the sides of the cask, till the bottom is only covered to the depth of 9 to 10 in. The vat is then filled anew with water, to which 4 per cent. by measure of saturated hydrosulphite is again added. The next day the water is again drawn off, and the sediment is thrown upon a filter, and washed. When completely drained, 7 lb. of a dense paste are obtained for every 2 lb. indigo originally employed. To preserve this paste, it is suspended in gum water. The yield, as above, is mixed with 44 lb. thick gum water, containing in each 1¾ pint 3 lb. 1 oz. gum. This mixture is the *bleu gommé*. Gum senegal should be used, as starch, calcined starch and tragacanth have given bad results.

Lapis resist, white (for block and machine).—5½ pints water, 6 lb. 9 oz. lime-juice at 53½° Tw., 11 lb. pipe-clay. Mix also separately: 5½ pints water, 4 lb. 6 oz. lime-juice at 53½° Tw., 3 lb. 13 oz. corrosive sublimate, 11 lb. calcined starch, 12¾ oz. lard, 6½ oz. turpentine, 3¼ lb. muriate of zinc at 98° Tw. Mix and boil.

Lapis resist, red.—7 pints red liquor, 6⅜ oz. verdigris, 9 lb. 13 oz. pipe-clay, 4⅞ oz. lard, 4⅞ oz. turpentine. Dissolve also separately: 12¾ oz. arsenious acid, 5½ pints acetate of alumina. Mix also apart: 3½ pints acetate of alumina, 3¼ lb. gum senegal, 17¼ oz. muriate of zinc at 98° Tw., 8¾ fl. oz. extract of logwood at 6¾° Tw. Mix these three parts with the aid of heat, grinding them very well, and straining before use.

The cylinders for printing should be engraved very deeply. The pieces are next aged for 48 hours, at a temperature of 95° F. (35° C.) with the wet-bulb thermometer at 89° F. (32° C.). Dry for 12 hours thoroughly at 86° F. (30° C.). If left damp, the pieces will not resist the vat. Dye blue for 3 to 5 minutes in the cold vat. Drain, wash for ¼ hour in a current of water. Dung in folds for ½ hour in a beck at 140° F. (60° C.), with 4 pails of dung, and 15¼ lb. chalk, for 6 pieces of about 50 yd. Wash; and dung a second time in the same matter, but without chalk; and wash. Dye for 2 hours at 140° to 158° F. (60° to 70° C.), in the following beck: 8 lb. garancine (for which will now be substituted a proportionate quantity of alizarine), 6 lb. 9 oz. sapanwood, 11 lb. sumach, 17½ lb. bark, 7 pints glue in jelly (containing 17½ oz. dry glue). Wash till no more colour runs off; chlore at ¾° Tw. Wash; dry; back in yellow, if needed; and age for 24 hours at 86 F. (30° C.) the wet-bulb thermometer standing at 80° F. (27° C.).

Lightfoot's process for combining indigo and madder effects.—1¼ lb. dry indigo, ground and prepared, 1¼ lb. tin crystals, 1 gal. caustic soda at 30° Tw.; put into the colour pan, and raised to a boil in ½ hour, when 1 gal. boiling water is added. The mixture is then allowed to become quite cold, and 2 gal. cold water are added, in which ½ lb. sugar has been previously dissolved. To this solution are added 2½ pints muriatic acid at 32° Tw., or 1 pint ordinary oil of vitriol, previously diluted with 1 pint water, and allowed to stand till cold, or 3 qt. acetic acid at 80° Tw. The indigo blue may also be precipitated by a mixture of double muriate of tin at 120° Tw., with any of the acids above mentioned, taking ¼ pint of the tin solution to half the quantities of acid given above. But of all these precipitants, acetic acid alone is preferable. The indigotine precipitate is filtered through a deep conical filter, leaving exposed to the air as small a surface as possible. The pulp obtained from the above quantities, when filtered, should measure about 1 gal. To make a blue colour for printing, take 4 gal. of the above precipitated indigo, and 14 lb. gum senegal in powder, stirring till dissolved. The colour, when strained, is ready for printing. For a green colour, take 4½ gal. indigotine precipitate, 18 lb. powdered gum senegal, stirring till dissolved; 11 lb. nitrate of lead, and 11 lb. white sugar of lead, both in powder. The mixture is stirred till all is dissolved, and is then strained. Compound colours are made by mixing the blue and green with each other, or with ordinary mordants for dyeing. With the blue and green above described, and with the ordinary iron and alum mordants (as used in madder-work), print calico, and, after cooling, age the pieces for a night. They are then fixed by passing into a solution of silicate of soda at 8° Tw., to which is added 1 oz. powdered chalk in a gal. This bath is in a cistern fitted with rollers at top and bottom, and heated to 90° F. (32° C.). The pieces pass through this solution at the speed of 25 yd. a minute. They are then rinsed in a tank of cold water, fitted with a reel about 4 ft. above the surface. By this process, the indigotine attached to the fibre is rendered blue. If the green mixture has been printed the one pieces are next passed into a chrome beck at 100° F. (38° C.), containing 1 oz. bichromate of potash in a gal. of water. Here the pieces remain for 5 minutes, and are then washed. They are next submitted to second dunging (the passage through silicate of soda being the fly-dunging) for 15 minutes, at 100° F. (38° C.), in a beck of cow-dung and water. They are next washed in water, and dyed with madder, munjeet, flower of madder (alizarine), garancine, cochineal, or mixtures of garancine with sumach and bark. The grounds are then cleared in the ordinary manner, preferably with chloride of lime.

White reserve. (1) Block.—3 lb. Bluestone, 1 gal. water, 15 lb. pipe-clay. Beat up with some of the solution; mix gradually to a smooth paste, and add 1 gal. thick gum senegal water, and 1 qt. muriate of copper at 80° Tw.

(2) Machine.—2½ lb. blue-stone, 1 gal. water, 9 lb. flour, 2 lb. British gum (dark).

White resist (for lighter vat-blues).—25 lb. dark British gum, 15 lb. water. Boil for 10 minutes; and add 7½ lb. soft-soap. When thoroughly incorporated, add 20 lb. sulphate of zinc. Stir in well, and add further :—7½ pints water, 10 lb. pipe-clay, 7½ gal. nitrate of copper at 80° Tw. Work all thoroughly together.

Orange reserve.—Heat 2 lb. water to a boil, and add, with constant stirring, 1 lb. sugar of lead, and ½ lb. litharge; boil for 20 minutes, and add to the liquid, to which more water must be supplied, to compensate for the loss by evaporation, 1 lb. blue-stone, 2 lb. nitrate of lead, and 1½ oz. verdigris, previously softened in acetic acid. The whole is let stand for a day, with frequent stirring; 1¼ lb. powdered gum senegal, and 1 lb. sulphate of lead, are then stirred in; and lastly, 2½ oz. powdered sal ammoniac, and 1 oz. lard are added. If the colour is too stiff, it is diluted with water. It is then strained, and printed on at about 122° F. (50° C.). Age for a day or two at 66° to 77° F. (19° to 25° C.). Dye in the cold vat; dry, and sour at ¾° Tw. For raising the orange, take for 100 yd., 175 pints water, containing 8 lb. chromate of potash, and 16 lb. lime. Let settle; run off the clear, and heat to a boil, at which temperature the pieces are passed through at such a speed that each part may occupy 3 minutes in traversing the liquid. Rinse well.

Yellow reserve.—20 lb. blue-stone, 2 gal. water, 20 lb. nitrate of lead. Dissolve; and thicken with 12 lb. flour, 2 gal. sulphate of lead pulp. Boil well together. The sulphate of lead pulp here mentioned is the sediment left on making red liquor with solution of sugar of lead and alum (or sulphate of alumina), after the liquid has been run off.

Blues.—To produce a pale-blue pattern on a deep-blue ground, the entire pieces are first dyed a light shade in the vat. They are then withdrawn, thoroughly washed in water, taken through vitriol sours at 2° Tw., washed again, squeezed, and dried. One of the white reserves is then printed on, and the pieces are returned to the vat, and dyed the darker shade. The reserved parts appear as a pale-blue pattern on a deep-blue ground.

To obtain a design in two blues on a white, muriate of manganese is printed on, thickened with dark British gum, and is then peroxidized by being passed through chloride of lime and soda, as in the production of "bronzes." The goods are then dried, and those parts of the pattern which are to appear white are printed with a white reserve. The goods are next limed, vatted to shade, taken out, aired to oxidize the indigo, washed, and rinsed in weak muriate sours, to which a little protochloride of tin has been added. The pattern appears then in white and dark-blue on a light-blue ground, the white being where the discharge was applied, and the dark-blue where the indigo is fixed upon a bottom of manganese brown.

If yellow or orange is to be obtained in addition, the yellow or the orange reserve is blocked in beside the muriate of manganese and the white reserve. Vitriol sours must be used here, and the yellow is then developed by a passage through bichromate of potash at 100° F. (38° C.), containing 2 oz. per gal. Wash in water, and pass through muriate sours at ½° Tw., with the addition of 1 oz. oxalic acid per gal.

If a blue and green design is intended, the yellow discharge given, or one of a similar character, is printed on, and the goods are dipped in the vat to a full blue, washed, aired, washed again, taken through vitriol sours at 2° Tw., washed again, and passed through the bichromate beck, but without any treatment in oxalic-muriatic sours. The green is formed by the combination of the yellow and the blue.

To produce two shades of the blue with a green, the cloth is vatted to a pale-blue, a white reserve for light shades, and an orange reserve, are printed in. The usual operations are then gone through; but after the bichromate process, the pieces are taken through nitric acid, which must be very dilute, otherwise the indigo may be destroyed. The result is a dark-blue ground, with a design in pale-blue where the white resists have been applied, and in green where the orange has been printed.

Discharges on Vat-Blues.—Give a medium blue in the vat. Steep pieces in bichromate of potash (4⅗ oz. in 1¾ pint water), and dry on rollers, avoiding sun-light. Print on the following discharges:—

White.—7 pints water, 2 lb. 7¼ oz. white starch. Boil, and add while still warm, 2 lb. 3 oz. tartaric acid, and then 21½ oz. oxalic acid, dissolved in 1¾ pint water.

Red.—14 qt. red liquor, 17½ lb. white starch. Boil; let one half grow cold, and add to it 7 lb. 10 oz. oxalic acid. Then add the other half of the hot mixture to complete the solution of the acid.

The red liquor consists of 2 lb. 3 oz. alum, the same weight acetate of lead, 3½ pints water.

Print on the white and red discharges with the perrotine, or with a two-colour cylinder machine. Do not dry too strongly. Age in hot, but not moist, air, which is an essential condition. The next morning, dung as follows:—Into a beck with rollers, put 6 lb. 9 oz. neutral arseniate of potash, 27 lb. 7 oz. chalk, and 1750 pints water. Pass the pieces slowly through at a simmer, so as to keep the chalk in suspension. After leaving this beck, the pieces are strongly compressed between two rollers covered with cloth. After the first 5 pieces have passed, feed the beck with 1¾ oz. arseniate of potash, and a little chalk, per piece. After thus cleansing the pieces, dye up in alizarine, and take through boiling water.

Green and Yellow on a Deep-blue Ground.—Boil the pieces with 2 lb. 3 oz. soda-ash per 100 yd.; wash well, and take through a weak soda beck, containing per 100 yd., 8¾ oz. soda-ash at 100° F. (38° C.). Dry, calender, and dye a blue in the cold vat. Take through sulphuric acid at 1·4° Tw., starch slightly, dry, and calender cold. Print the following colours on the blue ground:—

(1) Green Discharge.—26¼ lb. pipe-clay, 6 lb. 9 oz. gum arabic, the same weight of blue-stone, and of verdigris, 13 lb. 2 oz. nitrate of lead, and 6 lb. 9 oz. sugar of lead. The verdigris is dissolved in acetic acid, and the gum in water; the two solutions are stirred together, and the pipe-clay, previously softened in water, is added. The other ingredients are powdered, and stirred in by degrees. Water is added, enough to make the mixture fit for printing; when it is boiled, the water lost by evaporation is replaced, and the colour is then ready.

(2) Yellow Discharge.—19 lb. 11 oz. pipe-clay, 2¾ lb. verdigris, 2 lb. 7½ oz. blue-stone, 3¾ lb. nitrate of copper, the same weight of gum arabic, 15½ pints water, 6¾ lb. nitrate of lead, the same weight of sugar of lead, and 4 lb. 6 oz. nitric acid at 143° Tw. Make up the colour without the nitric acid, stir all well together, and stir in the nitric acid just before using.

Print on first the green and then the yellow. Age in the cold, till the discharge becomes visible on the back of the pieces. Take them through a weak vat to wet them, and then dye up to shade in a fresh vat. Sour without drying, wash off the colours, rinse, take through weak lime-water to remove the acid, and then through a beck of chromate of potash, containing 3¼ lb. chromate per 87 qt. water. The pieces are caused to move very slowly, so that the dyeing process may go on satisfactorily. Rinse, dry, stiffen, and calender.

Madder Colours.—This style on the Continent is generally characterized as "dyeing mordants," or "dyeing upon mordants," a preferable name, since the essence of the style is that merely mordants, duly thickened, are printed upon the pieces. The cloth is then worked in a dye-beck (formerly with madder, now with coal-tar alizarine and anthrapurpurine), as if the object were to produce a uniform colour. As, however, the mordants have been applied to certain parts of the surface only, the colour attaches itself to these alone, producing the design. The colours thus obtained are then cleared or brightened, and the white ground is freed from all traces of colour.

The subjoined are some of the more important of the mordants (called by the misleading name of "colours") printed on for the production of special effects in the madder style:—

Black (for machine work).—4 gal. black liquor at 34° Tw., 4 gal. crude acetic acid, 4 gal. water, 24 lb. flour. Grind the flour to a smooth paste with a little of the mixed liquid, stir in the rest, boil, and stir in 1 pint of gallipoli. No clots must be allowed to remain.

It must be noted that blacks are less frequently produced by the madder style than was formerly the case, as the aniline black is more and more taking their place.

Brown Standard.—50 gal. water, 200 lb. catechu. Boil 6 hours, and add 4½ gal. acetic acid. Make up to 50 gal. with water. Let stand for 2 days; decant the clear, heat to 130° F. (54° C.), and add 96 lb. sal ammoniac, dissolve and let settle for 48 hours, decant the clear, and thicken with 4 lb. gum senegal per gal.

For machine work.—8 gal. brown standard, as above, 1 gal. acetate of copper, as below, ½ gal. acetic acid, ½ gal. gum senegal water (4 lb. a gal.).

To make the acetate of copper, take 4 lb. blue-stone, 4 lb. sugar of lead, 1 gal. hot water. Dissolve; let settle, and set the clear at 16° Tw. with water.

Madder Brown to resist heavy covers of Purple.—½ lb. catechu, ¼ lb. sal ammoniac, 1 qt. lime juice at 8° Tw., 2½ oz. nitrate of copper at 80° Tw., 1½ oz. acetate of copper, 1 lb. gum senegal.

Chocolate.—3 gal. iron liquor at 24° Tw., 6 gal. red liquor at 18° Tw., 14 lb. flour, 1 pint logwood liquor.

Drab.—4 gal. brown standard, 1 gal. proto-muriate of iron (ferrous chloride) at 9° Tw., 3 gal. acetate of copper, 1 gal. gum substitute water, containing 4 lb.

Purple.—Add to the iron liquor, in proportions varying according to the shade, 40 lb. light British gum, 16 gal. water, 2 gal. purple fixing liquor. Boil well together; draw off, and allow the whole to stand for 3 to 4 days. Of this, 8 to 30 gal. may be added to 1 gal. black liquor.

Padding Purple.—Make up a thickener as follows:—13½ gal. water, 2 gal. purple fixing liquor, 2 qt. logwood liquor at 8° Tw., 18 lb. flour. Boil, and add 2½ gal. of farina gum water, made by boiling 6 lb. dark calcined farina in 1 gal. water.

Purple Fixing Liquor.—(1) 7½ gal. water, 1½ gal. acetic acid, 9 lb. sal ammoniac, 9 lb. arsenious acid. Boil till all the arsenic is dissolved; let stand to settle, and decant off the clear for use.

(2) 2 gal. water, 25 lb. soda crystals, 22½ lb. white arsenic. Boil till dissolved, and add 50 gal. raw acetic acid, which should first be heated to 120° F. (49° C.). Let settle for some days; decant off the clear and add 3 qt. muriatic acid at 32° Tw.

Purple Assistant Liquor.—100 lb. potato starch, 37½ gal. water, 123 gal. nitric acid at 60° Tw., 4 oz. black oxide manganese. When the reaction is over, and the nitric acid is destroyed, add 50 gal. pyroligneous acid.

Red, Dark (for machine work).—6 gal. red liquor at 18° Tw., 12 lb. flour.

Standard Red Liquor.—20 lb. alum, 12½ lb. sugar of lead, 5 gal. boiling water. Stir till dissolved; let settle, and draw off the clear.

Dark Red, for resisting a chocolate cover.—12 gal. resist-red liquor (see below) at 18° Tw., 24 lb. flour. Boil well, and when almost cold, add 12 lb. tin crystals.

The resist-red liquor consists of 90 gal. acetate of lime at 24° Tw., 272 lb. sulphate of alumina, 34 lb. ground chalk.

Red, for resisting purple covers.—6 gal. resist-red liquor at 14° Tw., 12 lb. flour; boil; when nearly cold, add 2¼ lb. tin crystals.

White figures are obtained by printing on some mixture like the following:—1 gal. lime juice, at 8°, 20°, or 30° Tw., 1 lb. starch. Boil, and stir till dissolved. Where this so-called "acid" is printed in, covers and padded grounds subsequently printed take no effect, and the figure remains white. Upon such whites, steam colours may be afterwards blocked in, and thus a great variety of effect is obtained.

MANGANESE BRONZE STYLE. — A brown ground is produced over the entire surface by padding in solutions of a salt of manganese, drying, padding in soda lye, first at 24° Tw. then at 12° Tw., rinsing in water, taking through bleaching lime at 2° Tw., washing again in water, and drying. By these processes, manganese peroxide is uniformly deposited over the fibre. Various colours are then printed upon this ground, so made up as to discharge it, and become fixed in its place, the result being designs in white, black, red, green, blue, yellow, &c., on a brown ground. After printing, the pieces are hung up for a few hours, rinsed in a flow of water, in chalk water, then in pure water, and, in case of chrome yellow greens, in a solution of bichromate of potash at about 40° Tw. Lastly, the goods are washed and dried. As specimens of the discharge colours printed on, the following are given :—

Pink.—1 gal. Brazil-wood liquor at 12° Tw., 2 oz. blue stone, 2 oz. sal ammoniac, 2 lb. starch. Boil, and add 8 fl. oz. oxymuriate of tin at 120° Tw. Mix 2 qt. of the above colour with 1 qt. double muriate of tin at 120° Tw.

White.—2 gal. water, 8 lb. light British gum. Boil, and add 8 lb. tartaric acid, 1 gal. double muriate of tin at 120° Tw.

PADDING STYLE.—This is a modification of the madder style. The pieces are padded over with red and black liquor, dried in the so-called padding-flue; the pattern is printed on in lime-juice and bisulphate of potash, thickened generally with starch, thus removing the mordant from certain parts. After ageing, dunging, and dyeing, the design appears in white on a claret, scarlet, or purple ground. It is, of course, easy to convert the white design into a yellow, or to block in steam or pigment colours.

PIGMENT STYLE.—The colours employed in this style are insoluble pigments, which are fixed upon the fibre by various mediums, and offer the advantages of solidity and permanence, combined with a lightness and brilliance equalling, in many cases, those of colours formed in the fibre. The pigments chiefly employed are ultramarine of various shades, from greenish-blue to a full blue, violet-blue, and even a reddish-violet; vermilion; several ochres; zinc-white; certain chrome colours, such as chrome-yellow, chrome-green, Guignet's green, Wilner's green, lamp-black, sienna, umber, &c. The vehicles or mediums for attaching these pigments to the fabric are albumen and caseine (often called lactarine). Blood-albumen may be used for all save the lightest and brightest colours. The pigments are ground up in albumen, thickened often with gum tragacanth, printed and steamed. The albumen is thus coagulated, and the colour is permanently attached to the fibre. Pigment printing is chiefly confined to such parts of designs as consist of small dots, stars, and flowers; more rarely to broad stripes, large foliage, &c. It affords the means of producing many pleasing effects which would not otherwise be practicable. Pigment colours, and other colours fixed by means of albumen, may be discharged by printing in the juice of the papaw-tree (*Carica Papaya*), thickened with gum.

Aniline Black: (1) For Yarn Printing.—$1\frac{3}{4}$ pint gum tragacanth water, $2\frac{2}{3}$ pints water, $9\frac{3}{4}$ oz. sublimed aniline muriate, $2\frac{3}{4}$ oz. chlorate of potash. Immediately before use, work in $2\frac{3}{4}$ oz. sulphide of copper. The colour thus made is printed; the pieces are dried and aged for 48 hours at 86° F. (30° C.) in a moist atmosphere. As soon as the colour appears of a blackish-green, the yarns are washed, taken through weak bichromate of potash, then through a solution of soda, washed and dried.

(2) For Machine Work.—159 oz. each chlorate of potash and sal ammoniac, 150 oz. moist sulphide of copper, 360 oz. white starch, 180 oz. calcined starch, 2300 oz. water. Boil, stir till cold, and add 317 oz. sublimed aniline salt, previously dissolved in 9000 oz. cold water.

(3) Prussiate.—34 oz. chlorate of aniline, 12 oz. prussiate of aniline, 34 oz. water, 12 oz. gum tragacanth water (containing $4\frac{3}{8}$ oz. per $1\frac{3}{4}$ pint). This mixture may also be thickened with starch paste, both for block and machine work. The chlorate of aniline is prepared by dissolving 5 oz. tartaric acid in 10 oz. boiling water, and, separately, 4 oz. chlorate of potash in 12 oz. boiling water. These two hot liquids are mixed together, 20 oz. cold water and 3 oz. aniline being added. After this addition, the liquid takes a faint yellowish tinge, and stands at $9\frac{1}{2}$° Tw. To obtain a prussiate of aniline, treat 7 oz. yellow

prussiate with 3 oz. sulphuric acid, previously diluted with 14 oz. water. After some days, the yellow colour disappears, and a deposit of sulphate of potash is formed. To 100 oz. of the solution thus obtained, are added 128 oz. of water and 20 oz. aniline.

(4) *White Discharge upon Aniline Blacks.*—Thicken an acid solution of the permanganate of potash with finely-ground siliceous earth and China-clay, and block on. Take through oxalic acid when dry. No organic matter must be used for thickening the permanganate.

(5) Aniline Black, with Design in White, Madder Red, and Chrome Orange.—This process illustrates the manners in which aniline black may be combined with other colours. For the madder red, is used a mordant of red liquor at 12° Tw., thickened with 2¼ lb. flour per gal. Cool, and add, per gal., 4 oz. tin crystals. For the orange, dissolve 4½ lb. nitrate of lead, 4½ lb. white sugar of lead, in ⅓ gal. water. Add ⅔ gal. gum Barbary water (6 lb. to the gal.). For the black, mix 1 gal. of the colour below, just before printing, with ½ pint sulphide of copper paste. To make the colour, thicken 6 gal. clear chlorate of ammonia with 36 lb. British gum. Heat to 150° F. (66° C.), let stand till cold, and add 4 qt. aniline oil, and 3 qt. best muriatic acid at 34° Tw. Mix well together. To make the chlorate of ammonia, dissolve 7½ lb. tartaric acid in 6 gal. boiling water. When dissolved, add gradually 3 lb. 2 oz. sesquicarbonate of ammonia. Now add 8 lb. chloride of potash, and stir till dissolved. Let stand till cold, and filter. Wash the precipitated tartar (potassium bitartrate) with 6 qt. cold water. This should yield 6 gal. clear chlorate of ammonia solution. For the sulphide of copper, take 2 lb. 2 oz. flowers of sulphur, 11½ lb. caustic soda lye (70° Tw.). Stir well till dissolved, without heat; add it to 10 lb. blue-stone, dissolved in 20 gal. boiling water. Wash till neutral to test-paper, and filter till the bulk of the paste is reduced to 1 gal.

Print the above black, red, and orange colours, and hang in a room at 70° F. (21° C.) with about 8° to 9° F. difference between the wet- and dry-bulb thermometers. Age till black, and pass through ammonia gas. Hang in a cool room for a few hours, and pass through the following solution at 160° F. (71° C.):—2 lb. sulphate of soda, 1 oz. phosphate of soda, 1 gal. water. Wash, and give a second dunging for 25 minutes at 130° F. (54° C.) in 100 gal. water, 2 lb. sulphate of soda, 1 oz. phosphate of soda, and 4 qt. solid cow-dung. Wash, and dye with 13 lb. madder, or a proportionate quantity of alizarine, per piece. Wash, pass through chloride of lime at 1° Tw., then steam, and wash. Dry, and steam for ½ hour at 2 lb. pressure. Wet out, soap-wash, and pass through weak sours (1 part oil of vitriol at 170° Tw., to 1000 water) at 60° F. (15° C.) for 6 minutes. Wash, and pass through chloride of lime, as before. Wash, dry, and raise orange in the usual way, first in bichromate alone, and then in bichromate and lime at 212° F. (100° C.). Wash well, and pass through chloride of lime, as before. Wash and dry.

(6) Dissolve ⅞ to 1¼ oz. chlorate of soda in 17 fl. oz. water, and thicken as usual. In another vessel, thicken 17 fl. oz. water, and stir in 2¾ oz. muriate of aniline, with 1½ gr. chloride of vanadium. Equal measures of these two solutions are mixed, and printed at once. Age at a low temperature, as long as chlorine is given off, and raise the temperature till perfectly dry. Lastly, pass through a solution of bichromate of potash, wash, and dry.

(7) The cerium aniline black, of Jerens, is obtained by mixing 75 gr. bisulphate of cerous oxide with 2¾ oz. muriate of aniline, thickened as usual. The shade, after printing, appears a a light green, but after ageing for 24 hours at 77° F. (25° C.)—68° F. (20° C.) by the wet-bulb thermometer —it turns to a dark-green, and, after soaping and taking through an alkaline beck, it comes np a fine black.

Plate Style.—This is a modification of the madder style. For a "plate purple," a purple is printed on, and an "acid" as described, and the whole is covered over with a lighter purple. The pieces are then aged in the normal manner; fly-dunged at 170° F. (77° C.); and dunged a second time at 165° F. (74° C.). They are next washed and dyed, raising the temperature in 2 hours to 175° F. (79° C.), which heat is kept up for ½ hour. Wash, and soap, taking 1 lb. soap for 3 pieces of 30 yd. each, boiling for 30 minutes. Wash, and take for 5 minutes through a beck of 500 gal. water, with ½ gal. solution of chloride of lime at 8° Tw. Rinse; boil for ½ hour with 1 lb. soap per 5 pieces; wash; chlore again for 5 minutes; wring in 1 gal. bleaching liquor at 8° Tw., in only 200 gal. water, along with 2 lb. soda ash at 160° F. (71° C.).

RESERVE STYLE.—This is another modification of madder-work. Acid reserves, consisting of lime-juice and caustic soda, are printed on the pieces; next, the ordinary "colours" for madder reds, purples, chocolates, &c., are printed; and the goods, after the usual operations of ageing and dunging, are dyed. In the white portions reserved, steam or pigment colours may be blocked in.

SPIRIT COLOUR STYLE, OR APPLICATION COLOURS.—The colours employed in this style contain so large a proportion of acid mordants, chiefly the chlorides of tin (or, as they are technically called, "spirits"), that steaming would be impracticable. After printing, the goods are carefully dried, aged for a few hours, rinsed, washed with cold water, and are then ready for drying off. The colours are bright, but, as a rule, not enduring; and the cloth is often weakened by the action of the strong mordants. The colours bear a considerable resemblance to those employed in the steam style. The following are examples:—

Block Blue.—1 gal. water, 1 lb. yellow prussiate, 6 oz. alum, 20 oz. starch. Boil, and after letting cool down to 110° F. (43° C.), add 15 oz. nitrate of iron at 80° Tw., and 15 oz. oxymuriate of tin at 120° Tw.

Brown.—1 gal. berry liquor at 80° Tw., 2 lb. light British gum. Boil, and add 1 lb. tin crystals, and 2 qt. each of the pink and purple colours given below.

Chocolate.—3 qt. sapan liquor at 8° Tw., 2 qt. logwood liquor at 10° Tw., 1 qt. bark liquor at 13° Tw., 3 lb. starch. Boil; when cooled down to 110° F. (43° C.), add further 1 pint oxymuriate of tin at 100° Tw., ½ pint nitrate of copper at 80° Tw., and 1 pint olive oil.

Green.—Mix the blue and yellow colours here given, according to shade.

Pink.—(1) 1 gal. sapan liquor at 14° Tw., ½ lb. sal ammoniac, 1 gal. gum water at 6 lb. per gal., 1 pint oxymuriate of tin at 120° Tw.

(2) Special, for blocking in madder work.—4½ gal. sapan liquor at 10° Tw., 9 lb. pink salt (*i.e.* double chloride of tin and ammonium), 3 lb. sal ammoniac, 2 lb. blue-stone, 5¾ oz. oxalic acid, 1 pint water 4½ gal. gum senegal water (6 lb. per gal.), 1⅛ qt. oxymuriate of tin at 120° Tw.

Purple.—1 gal. logwood liquor at 8° Tw., 1 gal. water, 10 oz. copperas, 2 lb. starch. Boil, and add 1 pint protochloride of iron at 80° Tw., 1 pint oxymuriate of tin at 120° Tw.

Red.—3 gal. sapan liquor at 4° Tw., 1 lb. sal ammoniac, 1 lb. verdigris, 4½ lb. starch. Boil, and add when cold, 5 lb. pink salt, 1 lb. oxalic acid.

Yellow.—1 gal. berry liquor at 10° Tw., 8 oz. alum, 1 lb. starch. Boil, and add 1 pint double muriate of tin at 120° Tw.

Such of the coal-tar colours as can bear the presence of acids, e.g. acid rubine, may, if desired, be applied in spirit styles.

STEAM COLOURS.—This style includes the processes by which the aniline colours in the majority of cases are fixed upon cotton goods, and, in addition, the topical application of the artificial alizarine colours; also printing upon woollen, worsted, and silk tissues, as well as upon mixed fabrics, such as delaines, coburgs, &c. The aim of steaming is to get a moist heat, both the temperature and the degree of moisture being carefully regulated, according to the class of the goods, the nature of the colours,

&c. In some cases, the pieces after printing are exposed to the air, at common temperatures, for 12 to 24 hours before steaming; whilst in others, they are steamed immediately. Sometimes, the goods are steamed for a time, taken out to air, and steamed again; whilst on other occasions, the steaming is conducted for the necessary time without interruption. The temperature, the pressure, and the degree of moisture, vary greatly, some printers using very dry, and others very moist, steam.

Before the colours are printed on, the calicoes are generally "prepared" by the following process:—The pieces are padded in a solution of stannate of soda, commonly known as "alkaline preparing salts," at 10° Tw., in a machine fitted with wooden rollers. The padding is generally done twice, and in the meantime, the pieces are allowed to remain wet for about 1 hour; next they pass through sours (i.e. dilute sulphuric acid at 1½° to 3° Tw.), then into pure water, and are washed, so that no free sulphuric acid may remain upon them; but the washing must not be so severe as to remove the oxide of tin which has been deposited upon the fibre. The pieces are then drained in the centrifugal machine, carefully dried at a gentle steam-heat, and are ready for printing. For heavy shades, the strength of the solution of stannate may be raised to 24° Tw.; the pieces are left to lie wet for 2 hours, and are then taken through sours at 6° Tw., washed, and drained in the centrifugal. All these operations are repeated once more in the same order, and the goods are then dried. Care must of course be taken to keep the sours up to the same point of acidity. Without attention to this point, they become rapidly weakened, and the fixation of the tin being thus rendered irregular, the colour subsequently produced will be uneven. Preparation with stannate of soda is useful for calico, and is in general absolutely necessary for worsted stuffs, and mixed goods.

The following are examples of steam colours:—

Amber.—15 lb. gum substitute, ⅜ pint neutral olive oil, 3 gal. bark liquor at 12° Tw., 2¼ pints sapan liquor at 8° Tw., 3 qt. red liquor at 16° Tw. Half boil, and add 6 oz. tin crystals, previously dissolved in 2 pints of the red liquor. Mix, and add $\frac{1}{16}$ pint oxymuriate of tin at 120° Tw. Mix well, and strain as fine as possible.

Blacks: (1) Machine work.—1 gal. logwood liquor at 6° Tw., 1¼ lb. starch; boil, and add, whilst still hot, 5 oz. copperas; stir thoroughly, and when the mixture has grown almost cold, add 2 oz. gallipoli oil, and 10 oz. nitrate of iron, well neutralized.

(2) 1 gal. logwood liquor 12° Tw., 1 qt. gall liquor 9° Tw., 1 qt. mordant, 2 lb. flour, 6 oz. starch. For the mordant, mix 1 qt. acetic acid, 1½ qt. acetate of copper, 1½ qt. black liquor 24° Tw., 1 qt. red liquor 20° Tw.

(3) For Calico.—Dissolve in water 5 lb. 7 oz. solid French extract of logwood, and allow the liquor to settle. Dissolve separately in water 17¼ oz. gum tragacanth. Mix the two solutions, and boil. Boil out 2 lb. 3 oz. gall-nuts in water, and add the decoction to the above, making up to 17½ pints. Let cool, and stir in 2 lb. 3 oz. nitrate of iron at 30½° Tw., and the same weight of black liquor at 26¾° Tw. Print, and hang up for 2 days, or preferably for a few hours; steam well, and wash.

(4) For printing Cotton Yarns.—Dissolve in water 5 lb. 7 oz. solid French extract of logwood, and 17¼ oz. gum tragacanth. Make up the mixed solution to 21 pints, in which dissolve 4½ oz. extract of bark. Let cool, and stir into the mixture 2 lb. 3 oz. black liquor at 30½° Tw., and 17 oz. nitrate of iron at 98° Tw. Print, hang up for 2 days, steam, and wash. If a very blue tone is required, the nitrate of iron is left out.

Blues: (1) Dark, for cylinder work.—7 gal. water, 11 lb. starch, 2¾ lb. sal ammoniac; boil, and add, while hot, 12 lb. yellow prussiate, ground, 6 lb. red prussiate, 6 lb. tartaric acid. When nearly cold, add 1 lb. sulphuric acid at full strength, 2 lb. oxalic acid (previously dissolved in 2 lb. hot water), 6 gal. tin pulp. Tin pulp is prepared as follows:—The strongest double muriate of tin, a saturated solution of the protochloride of tin (stannous chloride), is mixed up with as much solution of yellow prussiate as will throw down all the tin as a ferrocyanide. Wash in water by decantation, and drain on a filter till it becomes a stiff paste.

(2) Aniline.—35 fl. oz. red liquor at 20¼° Tw., 35 fl. oz. bisulphite of soda at 39½° Tw., 3½ pints strong gum water, 3½ oz. aniline blue (Schlumberger, Brussels). The colour, when ready, is printed at once. The calico may either be printed without any preparation, or it may be padded in a soap-lye containing 1 oz. curd-soap per pint, and dried. After printing, steam for 1½ hour. Wash, take through lukewarm soap-lye. and sour in weak muriatic acid. Wash and dry.

(3) Prussian blue for shawls, &c.—Boil up 10 oz. starch to a uniform paste with 7 pints water: stir into it 2½ lb. yellow prussiate, 1½ lb. red prussiate, 7 lb. tin pulp, 4 lb. tartaric acid, ¼ lb. oxalic acid, 5½ pints water, and 1 oz. sulphuric acid.

Browns: (1) Catechu.—Boil 4 lb. catechu in water; let settle, and strain off the clear. The liquor thus obtained is mixed with 1 lb. red liquor at 8¼° Tw.; and thickened with ¾ lb. gum tragacanth.

(2) Dark.—6 lb. starch gum, 9 lb. satin gum, 2 pints olive oil, 16½ qt. red liquor at 17° Tw., 6 pints acetic acid at 7° Tw., 4 gal. catechu liquor, 4 lb. sal ammoniac, 4 qt. sapan liquor at 8° Tw., 4 qt. logwood liquor at 10° Tw., 1 qt. acetate of copper, 1 qt. nitrate of copper at 86° Tw. Boil well, and strain.

(3) Bimas.—336 oz. extract of bimas at 5½° Tw., 56 oz. acetic acid at 11¼° Tw., 56 oz. cubic catechu, 14 oz. sal ammoniac, 10 oz. verdigris. Thicken with 200 oz. gum arabic.

(4) Berry.—1½ gal. berry liquor at 20° Tw., 1½ gal. Brazil wood liquor at 8° Tw., 3 lb. alum, ¾ gal. lavender liquor, 1½ gal. gum senegal water at 6 lb. to the gal., 1½ lb. nitrate of copper at 100° Tw.

(5) Standard.—3½ gal. bark liquor 12° Tw., 3½ qt. sapan liquor 12° Tw., 1½ qt. logwood liquor 12° Tw., 3 gal. gum substitute water 8 lb. to the gal., 3½ lb. alum, 2 oz. chloride of potash, 5 oz. red prussiate. Light browns are obtained by letting this standard down with gum water.

(6) 3 gal. bark liquor 12° Tw., 3 gal. berry liquor 12° Tw., 2 gal. logwood liquor 12° Tw., 2 gal. sapan liquor 10° Tw., 48 lb. British gum. Boil, and add 3 lb. alum, 2 lb. sal ammoniac, 2 lb. sulphate of copper (blue-stone), 2 pints nitrate of copper 8° Tw., 3 gal. lilac standard. To prepare the lilac standard, take 4 lb. gum senegal, 8 oz. red prussiate of potash, 12 oz. alum, 1 oz. oxalic acid, 2 oz. binoxalate of potash (salt of sorrel). Dissolve in 1 gal. logwood liquor 20° Tw., previously heated to 173° F. (79° C.).

(7) 1 gal. berry liquor 3° Tw., ¼ pint logwood liquor 8° Tw., ½ gal. peachwood liquor 8° Tw., 24 oz. solid nitrate of copper, 24 oz. alum. Thicken according to shade with gum senegal water.

Buff.—1 gal. bark liquor 10° Tw., 3 gal. madder liquor, ½ gal. red liquor 14° Tw., 7 lb. starch. Boil, and add 2 oz. crystals of tin.

Chocolates: (1) Cylinder work.—2 gal. sapan liquor 12° Tw., 3 gal. logwood liquor 12° Tw., ½ gal. bark liquor 12° Tw., 1 gal. nitrate of alumina, 4 gal. water, 17 lb. starch. Boil, and add 2½ lb. red prussiate of potash, 8 oz. chloride of potash. To prepare the nitrate of alumina, take 4 gal. boiling water, 12 lb. crystal nitrate of lead, 12 lb. alum, 2½ lb. carbonate of soda crystals. Stir till perfectly dissolved, let settle, and decant the clear.

(2) Alizarine.—2 lb. Alizarine paste 15 per cent. 2½ gal. thickening, 1⅘ lb. nitrate of alumina 26¾° Tw., ⅘ lb. acetate of alumina 18¾° Tw., ⅘ lb. red prussiate of potash in hot water, 1 lb. acetate of lime 26¾° Tw. In order to obtain a yellowish chocolate, add, for each quart, 1 oz. extract of bark at 30½° Tw. This chocolate may also be prepared from stale red colours by adding to them, for each quart, ⅘ to 1 oz. red

prussiate of potash dissolved in hot water.

(3) Chromium.—Take 70 fl. oz. Pernod's extract of madder in paste, 70 fl. oz. acetic acid at 9½° Tw., and 105 fl. oz. acetate of chromium at 25¾° Tw. Mix well, print, and steam. In place of Pernod's extract, a proportionally smaller quantity of alizarine may be used.

(4) 12 qt. sapan liquor at 2° Tw., 3 qt. nitrate of alumina, 6 qt. logwood liquor at 12° Tw., 6 oz. yellow prussiate, 6 oz. red prussiate, 9 lb. chlorate of potash.

Cinnamon.—1 qt. cochineal liquor at 8° Tw., 1 qt. logwood liquor at 8° Tw., 1 qt. berry liquor at 10° Tw., 6 oz. alum, 4 oz. cream of tartar, ½ lb. starch. Boil, and while still warm, add 3 oz. tin crystals.

Drab.—(1) 2 gal. lavender liquor, 2 gal. blue standard. 2 qt. bark liquor 8° Tw., 20 to 35 gal. gum water. To make the blue standard, take 2 gal. water, 4 lb. yellow prussiate, ¾ lb. alum, 1½ lb. sulphuric acid 170° Tw.

(2) Dark.—4 qt. berry liquor at 12° Tw., 7 lb. gum substitute. Boil, cool, and add 24 oz. alum, 16 oz. copperas, 1 qt. logwood liquor at 2° Tw., 1 qt. cochineal liquor at 3° Tw.

Greens: (1) 7 pints berry liquor at 11¼° Tw., 1¾ pint red liquor at 11¼° Tw., 7 pints blue mixture. When cold, add 8¾ oz. solution of chloride of tin at 113½° Tw., 20 oz. white starch. Steam twice for 20 minutes each time; wash, dry, and finish with 350 pints cold water, 88 lb. white starch, and 4 lb. 6 oz. stearine. To make the blue mixture, dissolve 22 lb. yellow prussiate, 3¼ lb. tartaric acid, and 3¼ lb. oxalic acid in 87½ pints boiling water.

(2) Cæruleine.—17½ qt. gum water, 7 qt. cæruleine, 1¾ pint bisulphite of soda. To be added on using, 3½ pints acetate of chrome at 26¾° Tw.

(3) Bark.—2¼ lb. starch, 1½ gal. bark liquor at 16° Tw. Boil, and add 9 oz. alum, 1½ oz. oxalic acid, 8 oz. tin crystals. When half cold, add 1 lb. 14 oz. tartaric acid, 3 lb. 6 oz. yellow prussiate, 1½ pint tin pulp, ⅝ pint olive oil. After steaming, pass through chrome liquor at 4½° Tw. Wash in clear water, and dry.

(4) Aloes.—Chrysammide (the product of chrysammic acid on treatment with ammonia), thickened according to shade with gum water. After steaming, this colour comes up a rich moss green, which is not affected by boiling water, nor by the madder baths, and is capable consequently of a variety of useful applications. Thus an aloes green ground may be obtained; iron and alum mordants may be printed on, and the piece may be dyed with alizarine, giving red, purple, chocolate, and black figures on a green ground.

(5) For blotch grounds.—4 gal. bark liquor at 10° Tw. boiled up with 6 lb. starch. Add 2½ lb. alum, 3 lb. tartaric acid, 6 lb. yellow prussiate of potash, 12 oz. oxalic acid, and ¼ gal. tin pulp. After printing, take through a weak bath of bichromate of potash, to raise the colour.

(6) For block work.—14 lb. yellow prussiate, dissolved in 3 gal. very hot water. Mix meantime, in another vessel, 1 gal. water, ½ gal. double muriate of tin at 120° Tw., and 5 gal. gum senegal water at 6 lb. per gal. Now mix these two liquids by pouring them repeatedly backwards and forwards, and stirring thoroughly. When perfectly mixed, add 6 gal. berry liquor at 10° Tw., 5 lb. tartaric acid, 1¼ lb. oxalic acid, previously dissolved in 2½ gal. water, 1½ qt. acetic acid, 9/16 pint extract of indigo.

Greys: (1) Aniline for Calico.—Dissolve 21⅝ oz. chlorate of potash in 6 pints boiling water. When cold, add 11¾ pints gum water, 10⅞ oz. sal ammoniac, 3¼ lb. chromo-tartrate of potash at 49° Tw., 6⅞ oz. aniline, and 2 lb. 8½ oz. tartaric acid. Print on, age for 48 hours at 89° F. (32° C.), and wash for 1 hour. Lighter shades are produced by increasing the gum. This grey gives a fine ground, and can be submitted to all the operations necessary for alizarine reds, except passing through a salt of tin. To prepare the chromo-tartrate of potash, 33⅛ oz. bichrome are dissolved in 5½ pints boiling water. When it has cooled down to 110° F. (43° C.), add gradually 3 lb. 2⅛ oz. tartaric acid in fine powder, avoiding a rise of the temperature.

(2) Uranium Madder.—Add together 70 fl. oz. extract of madder in paste, 74 fl. oz. acetic acid at 9½° Tw., and 105 fl. oz. acetate of uranium at 14° Tw.

Lavender.—4 gal. lavender liquid, 4 gal. blue standard, 24 to 48 gal. gum water. The lavender liquid is prepared by mixing 2 gal. red liquor at 18° Tw. with 6 lb. ground logwood. Steep for 48 hours, and strain off the clear. A stronger quality is made from 10 lb. logwood with the same quantity of red liquor. For blue standard, take 1 gal. water, ¾ lb. oxalic acid, 4½ oz. yellow prussiate, 28 oz. gum substitute.

Lilac.—6 gal. pink standard, 2 gal. purple standard, 20 lb. gum substitute. For pink standard, mix 4 gal. cochineal liquor at 6° Tw., 2 lb. alum, 2 lb. cream of tartar, ½ lb. oxalic acid. For purple standard, 2 gal. logwood liquor at 12° Tw., 12 oz. alum, 8 oz. red prussiate, and 4 oz. oxalic acid.

Orange.—Mix 9 lb. 13 oz. saturn red (Baden Aniline and Soda Co.), 7 fl. oz. glycerine-arsenic, 44 fl. oz. water, 10½ pints blood-albumen thickening, 3½ pints gum water. The gum water is made by dissolving 21¾ oz. gum senegal in 1¾ pints water. For the glycerine-arsenic, dissolve 2 lb. 8¾ oz. arsenious acid in 17½ pints glycerine at 36° Tw., and concentrate to 100° Tw. To make the blood-albumen thickening, dissolve 13 lb. 2 oz. blood-albumen at a gentle heat in 16 pints water, 7 fl. oz. caustic ammonia at 10 per cent., and 8½ fl. oz. oil of turpentine. Print, dry, steam, and wash.

Pinks: (1) Sapan-wood.—1 gal. sapan liquor at 3° Tw., 1 lb. pink salt, ½ lb. sal ammoniac, 1 oz. oxalic acid, 1 oz. blue-stone, 1 gal. thick gum water.

(2) Standard (Cochineal). — 4 gal. cochineal liquor at 6° Tw., 2 lb. alum, 2 lb. bitartrate of potash (cream of tartar), ½ lb. oxalic acid, 4 gal. thick gum senegal water.

(3) Mixed.—5 gal. sapan liquor at 8° Tw., 1 gal. cochineal liquor at 8° Tw., ¼ lb. nitrate of alumina, 3 lb. alum, 2 oz. oxalic acid, 8 oz. chlorate of potash. When these ingredients are perfectly mixed up, add 12 gal. gum water.

(4) Cochineal. — 1 gal. cochineal liquor, 8° Tw., 20 oz. starch. Boil a little, and add 3 oz. oxalic acid. Dissolve, strain, print, steam for 40 minutes at 3 lb. pressure; let lie for a night, and run through very weak alum-water.

Purples: (1) Alizarine.—1⅘ lb. alizarine paste, 15 per cent., 2½ gal. thickening for purple, ⅔ lb. pyrolignite of iron, 17° Tw., ¾ lb. acetate of lime, 23½° Tw. After printing, the pieces are steamed for 1 to 2 hours at a pressure of ½ atmos., and then aged for 24 to 36 hours. The steam should be very moist. The pieces are gathered on rollers, and rinsed for 1 to 1¼ hour through the following baths, heated to 122° to 140° F. (50° to 60° C.) :—250 gal. water, 40 lb. chalk, 10 lb. arseniate of soda. Wash, soap for ½ hour in a bath containing 3 lb. soap to 10 pieces of 50 yd. each, heated to 140° to 160° F. (60° to 71° C.). Wash; dry; if needful, give another light soaping. The best results are obtained by steaming perfectly dry pieces with wet steam. The thickening for purples, above mentioned, consists of 12 lb. wheat starch, 4½ gal. water, 2¼ gal. tragacanth mucilage, 3 qt. acetic acid, 11·2° Tw., 2 lb. olive oil.

It is to be remarked that alizarine shades, when obtained by dyeing upon mordants previously printed upon the fibre, are more beautiful, more transparent, faster, and more economical than when fixed by steaming. Hence alizarine colours ought not to be applied by steaming, except when it is absolutely necessary, i.e. when blues, greens, yellows, oranges, catechu browns, greys, mauves, &c., have to be associated with alizarine reds and purples.

(2) Logwood.—1¼ gal. logwood liquor at 16° Tw., 1½ gal. red liquor at 20° Tw., 1 oz. carbonate of soda, 5 oz. crystal soda, 5 oz. red prussiate, ¾ lb. oxalic acid, 10 lb. gum senegal. Boil, cool, and strain.

Reds or Roses: (1) Magenta.—¼ oz. magenta crystals, 6½ oz. acetic acid, 3 oz. water. Dissolve at a boil. Meantime mix for thickening 17½ fl. oz. red liquor at 21¾° Tw., 17½ fl. oz. water, and 12 oz. dextrine. Boil, cool, and mix with 4½ oz. thick gum water.

(2) ½ to ¾ oz. magenta crystals, ¼ lb. alcohol, 10 oz. boiling water. Dissolve, and add ¼ oz. oxalic acid. Thickening:—17½ oz. thick gum water, 18 oz. decoction of galls at 11¼° Tw., 9 oz. acetic acid. Mix, and add to the red; and stir in further 17½ oz. thin gum water.

(3) 1¾ pint red liquor at 14° Tw., 2¾ oz. arsenite of soda, and ⅝ oz. magenta. Steam for 1 hour, soap, and wash in pure water. This process is applicable also to other aniline colours.

(4) Aniline Rose.—35 oz. water, 6 oz. starch, 35 fl. oz. red liquor. Dissolve, and stir in 7½ oz. roseine carmine (Baden Aniline Works).

(5) Saffranine for Calico.—Mix ½ pint saffranine paste with 10 pints of the subjoined thickening:—1 gal. acetate of alumina (red liquor) standard, 1 gal. water, and 2 lb. starch. Boil, cool, and add 1 pint arsenic and glycerine standard. The acetate of alumina standard is made with 1 gal. boiling water, and 2¼ lb. alum. Dissolve, and add 3 lb. white acetate of lead. Dissolve, let settle, and use the clear. The arsenic-glycerine standard is composed of 1 gal. white glycerine, 4 lb. arsenious acid; boil till dissolved, and filter. Print the colour on, and steam for ½ hour.

(6) Dissolve ¼ oz. saffranine in 3½ oz. hot water. Make prepared thickening: 2 lb. 3 oz. acetate of alumina at 21¾° Tw., 17½ oz. arsenite of soda at 98° Tw., 1 lb. 10 oz. acetic acid. Mix; dissolve separately 2 lb. 3 oz. soda, and the same weight of white arsenic in 2⅝ pints of water. Mix all together, and 3 lb. 4 oz. gum water at 2 lb. 3 oz. per 1¾ pint. Take 5 lb. 7½ oz. of the thickened, and 1 lb. 1½ oz. solution of saffranine. Steam as in the former process. This colour is applicable for mixed goods.

(7) Eosine.—Print with a thickened solution of eosine; steam, and pass into a bath of acetate of lead.

(8) Animalize with albumen, and dye in solution of eosine.

(9) Thicken a solution of eosine with white starch, or gum tragacanth; add arsenite of alumina (i.e. mixture of arsenite of soda and red liquor as given under saffranine). Print upon cloth prepared with tin; steam, and wash.

(10) Mix a solution of eosine with acetate of lead, acetate of tin, or red liquor thickened. Print upon calico, prepared with tin or oiled; steam and wash. Upon oiled calico the shades are bluish.

(11) Prepare the calico with solution of glue; print on a mixture of eosine with 3 times its weight of tannin; steam, and wash.

(12) Grain Ponceau.—Boil 17½ oz. cochineal in 10½ pints water. Boil out the residue again in water; mix the decoctions, and evaporate down to 10½ pints; let cool, and settle. In the clear liquid, dissolve 6¼ oz. oxalic acid, 3½ oz. white starch, and 4⅗ oz. white glue. Print, steam at 190° F. (88° C.), and rinse.

(13) Grain Red for Mixed Silk and Cotton Goods.—Mix 1 oz. extract of cochineal at 6·8° Tw. (for heavy shades this may be doubled), with the same quantity of berry liquor at the same strength. Thicken with 17½ oz. gum tragacanth; boil, stir till cold; dissolve in the liquid, 8⅝ oz. oxalic acid, and 3⅕ oz. tin crystals. Make up to 17½ pints. Print, dry, hang up for 24 hours, steam for 1 hour at 212° F. (100° C.), and rinse.

(14) Alizarine Red for Grounds.—1⅗ lb. alizarine paste, 15 per cent. (if 10 per cent. 2 lb.); 1 qt. acetic acid at 8·2° Tw., 2 qt. water, ⅖ lb. olive oil, ⅖ lb. acetate of lime at 14° Tw., 1 lb. wheat starch. Boil the whole, stir well till cold, and add ⅖ lb. acetate of alumina.

(15) Ditto for Mille Fleurs.—5⅕ lb. alizarine paste, 15 per cent.; 10 qt. thickening for reds, ⅗ lb. nitrate of alumina at 21¾° Tw., 1⅕ lb. acetate of alumina at 17° Tw., ⅘ lb. acetate of lime at 23½° Tw.

(16) Ditto for very deep Reds.—6⅗ lb. alizarine paste, 15 per cent.; 10 qt. thickening for reds, ⅘ lb. nitrate of alumina at 21¾° Tw., 1⅕ lb. acetate of

alumina at 17° Tw., 1 lb. acetate of lime at 23½° Tw.

(17) Red without Olive Oil.—5⅗ lb. alizarine paste, 15 per cent.; 9⅗ lb. acetic acid at 11·2° Tw., 8⅗ lb. flour, ⅘ lb. water. Boil to a paste, stir till cold, and then add 5½ oz. acetate of lime at 23½° Tw., 2 lb. nitrate of alumina at 21¾° Tw., 3 lb. hyposulphite of lime at 12·6° Tw.

(18) Red and Pink.—3⅕ lb. alizarine paste, 15 per cent.; 8 qt. thickening for red, 1 lb. acetate of alumina, 17° Tw.; ½ lb. acetate of lime, 23½° Tw. For pink, add 2 to 3 times its weight of thickening for red.

If a dark-red design is to be covered by a lighter red, the dark-red is first steamed for 1 hour. After printing the second colour, it is again steamed for 1 hour, and hung up for 24 hours. The pieces are then taken through either of the two following baths:—(*a*) 250 gal. water, 60 lb. chalk, 3 lb. tin crystals. (*b*) 250 gal. water, 40 lb. chalk, 10 lb. arseniate of soda. The baths are heated to 122° to 143° F. (50° to 62° C.), and the passage lasts for 1 to 1½ minute. Wash and rinse in the following soap becks, each warmer than the former, and prepared as follows (for 10 pieces of about 50 yd. each):—First beck: 3 lb. soap, ¼ lb. tin crystals; heat 122° F. (50° C.); time, ½ hour. Second beck: 3 lb. soap; heat, 167° F. (75° C.); time, ½ hour. Third beck: 3 lb. soap; heat, 167° to 177° F. (75° to 80° C.); time, ¼ hour. After each soap bath, the pieces are well washed.

The thickenings and mordants here mentioned, are prepared as follows:—Thickenings for reds, No. 1.—12 lb. wheat starch, 7 gal. water, 1 gal. acetic acid, 8·2° Tw., 2¼ gal. tragacanth solution (2 oz. per qt.), 3 lb. olive oil, which must be thoroughly incorporated with the mass. Stir till perfectly cold. No. 2. —12 lb. wheat starch, 4½ gal. water, 4¼ gal. acetic acid, 8·2° Tw., 3 lb. olive oil.

Nitrate of Alumina Mordant.—20 lb. nitrate of lead, 20 lb. alum., 5 gal. boiling water. Let the sulphate of lead settle, and draw off the clear. If the nitrate of alumina is used instead of the acetate, it causes the red to turn more to a scarlet; but it requires the use of a little more acetate of lime than acetate of alumina.

Acetate of Alumina Mordants.—Dissolve first 68 lb. alum in 100 gal. water, and precipitate by adding a solution of 62 lb. soda crystals in 150 gal. water. This precipitate, which is a basic sulphate of alumina, is washed 3 times by decantation. It is then thrown on a filter, let drain, and pressed. Of the paste thus obtained, 30 lb. are placed in 6 qt. acetic acid at 11·2° Tw., and heated to 90° F. (32° C.), till complete solution has taken place. It is then filtered, and diluted with water to the strength required. As a general rule, 100 parts alizarine paste at 15 per cent. require 30 acetate alumina at 17° Tw.

Acetate of Lime Mordant.—The solution of acetate of lime at 32½° Tw. contains about 25 per cent. of the salt. For a neutral well-washed paste, at 15 per cent., about 15 per cent. of its weight of acetate of lime is used.

Alizarine reds produced by printing are never quite so beautiful as the corresponding shades obtained by dyeing upon mordants according to the madder style.

Violets: (1) Galleine.—35 qt. galleine paste, 17½ qt. gum water, 1¾ qt. acetate of chrome at 26¾° Tw. Print and steam.

(2) Hofmann's.—Mix the dissolved and filtered colour with red liquor, and with a solution of arsenious acid in glycerine. Thicken with gum and starch. Steam for 1 hour, and soap gently.

(3) Aniline.—½ oz. Hofmann's or Perkin's violet, 13½ oz. hot alcohol. (There are now violets perfectly soluble in water). Dissolve, filter, and add immediately 1½ oz. tannin, ¼ oz. oxalic acid. Let cool, and meantime mix 2½ lb. thick gum water, 18 oz. water, 18 oz. acetic acid. Stir up well, and add to the above solution of colour. Print and steam.

(4) 17½ oz. pure tannin are dissolved in 15⅝ pints gum water, and an amount of aniline violet is added according to the required shade. Print, steam, enter the

pieces at 135° to 180° F. (57° to 82° C.) into a bath of tartar emetic, containing $\frac{1}{2}$ oz. of this salt per $1\frac{3}{4}$ pint; wash and dry. Or the pattern may be printed on with a thickened solution of tannin, ranging from $\frac{3}{4}$ oz. per $1\frac{3}{4}$ pint for pale, to $4\frac{1}{2}$ *oz.* for full shades, steamed, and passed into a bath of tartar emetic. They are then well washed and dyed in the bath of aniline violet, raising the temperature gradually to a boil, which is kept up for 20 minutes. Wash, and soap slightly. This process is applicable to various other aniline colours.

Yellow.—4 gal. berry liquor at 12° Tw., $1\frac{1}{2}$ lb. alum.

China Grass.—In regard to dyeing, it somewhat resembles Tussah silk, being difficult to colour by the ordinary methods; it is therefore necessary to employ energetic methods, of which the principal consists in a preliminary mordanting of the fibre. For every 10 lb. of grass, use 100 pints water and 1 lb. soda crystals or caustic potash; heat to 176° to 194° F. (80° to 90° C.), work for 20 or 25 minutes, and wash thoroughly. Make a bath of 100 pints water, 1 lb. sulphuric acid; heat to 158° to 176° F. (70° to 80° C.), work for 20 to 25 minutes, and wash immediately. The fibre is then ready to receive ordinary dyes. (Mon. Teint.).

Cotton Dyeing.—Cotton, like all vegetable fibres, is easily injured by acids, consequently, neither mordants nor colours of a strongly acid character can be employed; otherwise the goods will be corroded, and the colours will fail to be duly absorbed. The solutions employed must be very feebly acid, neutral, or even alkaline. Another important feature is the temperature at which cotton is dyed. In the majority of cases it is worked in the cold, or at a "hand-heat," i.e. at about 90° to 100° F. (32° to 38° C.). It is most extensively dyed in the state of yarn, but a large quantity also after being woven. This especially relates to the mixed fabrics, known as Bradford goods, the warps of which are cotton, and the weft worsted. The perfection of cotton dyeing is to produce on these warps the same tone and depth of colour as are found on the worsted, so that the entire piece may appear level, and free from any cheeky character.

It will now be convenient to give a series of approved recipes for producing the principal colours upon cotton, selecting such as best illustrate the resources of the modern dyer, and having especial regard to aniline and its allied tinctorial substances.

Blacks.—(1) Fast. For 110 lb. cotton yarn or cotton wool.—$8\frac{3}{4}$ lb. solid extract of logwood, 5 lb. 10 oz. catechu. Boil up together, boil the yarn in the decoction for 1 hour, steep in the cold liquid for 24 hours; raise to a boil again; lift and air over night. Dissolve in sufficient fresh water $24\frac{1}{3}$ oz. chromate of potash, and $24\frac{1}{4}$ oz. blue vitriol, and work the cotton in this for $\frac{1}{2}$ hour. Lift, drain, and dissolve $2\frac{3}{4}$ lb. soda ash in the cold logwood liquor. Heat to 139° F. (87° C.), re-enter the cotton, work 15 minutes, and rinse. This colour bears washing and milling, and does not smear whites.

(2) Aniline, for 100 lb. Mix 6 lb. 9 oz. aniline oil with 8 lb. 12 oz. hydrochloric (muriatic) acid at 32° Tw. Let cool and add solution of 4 lb. 6 oz. chlorate of potash in 66 pints water, and finally add $43\frac{3}{4}$ pints of a solution of chloride of iron at 32° Tw. Steep the bleached yarn for 8 to 10 hours in the liquid, which must previously be diluted with water at about 100° F. (38° C.); take out and place it in a solution of soda at 23° Tw., to neutralize the excess of acid. Wash, and steep for $\frac{1}{2}$ hour in a beck made up with 66 pints water and 7 oz. chromate of potash at about 112° F. (45° C.). This treatment prevents the dye from subsequently turning green. Wash, and pass the yarn though a mixture of $17\frac{1}{4}$ oz. emulsive oil (such as is used by Turkey red dyers), 2 lb. 3 oz. potash, and 66 pints water. Dry at once.

(3) Aniline, for cotton yarns (De Vinant's). The cotton yarn, well boiled out, receives 7 turns in a beck, made up with 7 oz. sulphate copper for every 2 lb. 3 oz. yarn, dissolved in water slightly soured with muriatic acid; it

is then well wrung out. It next receives 5 turns in water at 122° F. (50° C.) containing 1¾ oz. sulphide of sodium per 35 fl. oz. liquid, and is again rinsed. It then has 7 turns in a beck of 17½ pints water, 6¼ oz. chlorate of potash, and 5¼ oz. sal-ammoniac, all dissolved by the aid of heat, and mixed with 16½ oz. muriate of aniline. It is then stretched out very regularly in a drying-room, and kept for 48 hours at 75° F. (25° C.). Lastly, it receives 4 turns in water containing 15¼ gr. bichromate of potash per 1¾ pint at 86° F. (30° C.), and is then well washed, and dried. If the black has a foxy tone, take through 87 qt. cold water, to which has been added 35 fl. oz. bleaching-liquor at 8° Tw. Without great care, the blacks produced by this process are cloudy.

(4) Aniline with vanadium (Pinckney's).—Take 150 oz. muriate of aniline, ⅛ oz. salt of vanadium, 20 oz. chloride of nickel, 100 oz. chlorate of potash, 2500 oz. water. The yarns are steeped in a mixture of these substances, and dyed either hot or cold. In subsequent practice, the chloride of nickel has been found unnecessary, and the salt of vanadium admits of a great reduction in quantity.

(5) Aniline.—Scour well, and for each 1 lb. cotton yarn, take 3⅕ oz. sulphate of copper, dissolved in water made very feebly acid with spirits of salt (muriatic acid). Give 7 turns and wring well. Dissolve ½ lb. hydrosulphide of soda per gal. of water at 120° F. (49° C.), give 5 turns, and wash well. Dye cold in 3 oz. chlorate of potash, 3 oz. sal-ammoniac, ⅓ lb. muriate of aniline dissolved in sufficient water. Give 7 turns quickly, wring well, and beat. Hang up evenly at 77° F. (25° C.) for 48 hours, and raise to 84° F. (29° C.). Take through either bichromate, or weak soda-lye; wash well. If reddish when dry, take through very weak chloride of lime liquor.

(6) Fast, for 60 lb. yarn.—Take through indigo vat. Then boil 5 lb. logwood extract, and 1½ lb. blue vitriol; steep yarns in this all night, and work in the morning, in 6 qt. nitrate of iron in sufficient cold water. Take through clear lime water, and wring out. Boil 5 lb. logwood extract, ¼ lb. fustic extract. Add this to sufficient hot water; work yarn in this for ½ hour; lift; add 2 lb. copperas; work again, wash off, and dry.

Blues.—(1) Methyl, 30 lb. yarn.—Dissolve 4 lb. Glauber salts, 2 lb. alum, in a sufficient quantity of water. Dissolve 1½ oz. methyl blue (of Meister, Lucius, and Brüning), and add it to the dye-beck. Enter yarn at 110° F. (43° C.), turning rapidly, and dye to shade, raising the temperature to 120° F. (49° C.).

(2) Light, 50 lb. bleached yarn.—Dissolve 3 lb. alum, 3 oz. tartaric acid, and ¼ oz. "water-blue 6 B" (Berlin Aktein Gesellschaft für Anilin-Farben). Enter yarns at 110° F. (43° C.), turn rapidly, and raise the temperature to 130° F. (54° C.), turning to shade. After the colour has become level, another ¼ oz. of the colour, previously dissolved, should be added to the beck.

(3) Corn Flower (Pittacal).—Prepare the cotton in a cold solution of tannin; wring and enter into a solution of tartar-emetic. Wring, and enter into a solution of acetate of pittacal, dissolved in acetic acid, diluted with a sufficient quantity of water, and then almost neutralized with ammonia.

(4) Navy, 11 lb.—Boil 2 lb. 3 oz. logwood, and dissolve in the clear hot liquid 26 oz. curd soap. Steep clear yarn in this liquor for 2 hours at 167° F. (75° C.). Lift; add to the beck 26 oz. copperas; re-enter the yarns, and work till the colour is even. Wash in cold water, and work in a fresh beck with 17¼ oz. curd soap at 144° F. (62° C.), for 1 hour. Then make up a boiling beck with 2½ oz. of an aniline blue, soluble in spirit, and 2 lb. 3 oz. red liquor at 13° Tw. Work the yarn in this at a boil till the desired shade is obtained, and finally rinse.

(5) Aniline, 11 lb.—Boil 2 lb. 3 oz. sumach, or 6⅛ oz. tannin in water; filter; dissolve 17¼ oz. curd soap in the clear solution, and enter the cotton over night into the hot liquor. Wring

out, and make up a beck with acetate of alumina at 3° Tw., to which a clear solution of aniline blue is added according to the shade. Enter the cotton, and dye, raising the temperature to a boil for some time.

(6) Methylene.—This colour dyes cotton without a mordant, producing rich blues with a greenish reflection, fast against soap and light. It dissolves readily in water.

(7) Indigo or Vat.—Indigo being insoluble, cannot be applied to textile fibres by the ordinary dyeing process. It requires to be reduced to so-called "white indigo," when it becomes soluble, and is in that state deposited on the tissues of yarns, where it rapidly resumes its ordinary blue insoluble condition, and remains permanently fixed in the fibre.

In the case of cotton, the indigo vat is generally "set" in the following method. To about 2000 gal. water are added 60 lb. indigo, ground to an impalpable powder, 180 lb. slaked lime, and 120 lb. copperas. The lime and the copperas are added from time to time. The lime is put in first, and the vat is well stirred up before adding the copperas. There must be always sufficient lime present to dissolve the white indigo as it is formed. But if too much lime be present, an insoluble compound is formed, which renders the indigo useless for dyeing.

The yarns or pieces are simply steeped in, or rinsed through, the clear liquid of the vat, and then exposed to the air, when the greenish colour which they take at first is soon converted into a blue. The dipping and airing are repeated till the shade is obtained. The goods are then taken through very weak sulphuric acid, thoroughly well washed, and dried.

The vat for dyeing cotton, or any other vegetable fibre, is always worked in the cold.

An improvement in vat dyeing was invented and patented some years ago, by Schützenberger and de Lalande. A solution of the bisulphite of soda, at 52° to 63° Tw., is placed in a covered vessel, containing zinc clippings, borings, &c., piled up so as to fill the tank, without occupying more that ¼ of its total contents. After 1 hour's contact, the liquid is drawn off into a cistern, containing milk of lime, which decomposes the zinc salts. The clear liquid is then strained off. Soda or lime sufficient to dissolve the indigo is then added, and it is mixed with the indigo, which must be in perfectly fine powder. At once is produced a yellow solution, containing no soluble impurities, except the earthy matters which were present in the indigo itself. Access of air is avoided as much as possible during this process. In this manner, 2 lb. 3 oz. indigo can be dissolved in 7½ to 26 pints of liquid. The vat is then filled with cold water, if for cotton, and a suitable amount of indigo solution is added. An excess of the "hydrosulphite" is always present, whence the reduced indigo solution is almost wholly avoided, the blue indigo being reduced as quickly as formed. The dye-liquor thus resists atmospheric action far better than the ordinary copperas vat, and is free from the inconvenience of always holding in suspension more or less peroxide of iron, carbonate of lime, &c., which must be allowed to settle before the vat can be used with advantage. By adding to the vat from time to time a little concentrated indigo solution, the strength can be maintained at any required point, and thus any given shade may be communicated by the smallest number of dips; the colours thus obtained are also brighter than those of the old process.

(8) Prussian, 10 lb.—Take 1 pint muriate of tin, 4 qt. nitrate of iron (so called blue iron), and 30 gal. water. Run the cloths or yarns 4 times through, and wash off.

Dissolve 1½ lb. yellow prussiate of potash (potassium ferrocyanide) in 30 gal. water, and add to it ½ pint oil of vitriol (full strength sulphuric acid). Run the piece, or turn the yarns, 4 times, and then raise the colour in a beck of 60 gal. water, ½ pint nitrate of iron, and ¼ pint oil of vitriol. Wash off, and dry.

Prussian blues are now almost entirely superseded by the coal-tar blues.

Browns.—(1) Fast, 110 lb. cotton yarns.—Dissolve 22 lb. catechu, and 2 lb. 3 oz. blue vitriol (sulphate of copper), in boiling water; steep for 1 hour in the boiling hot liquid; lift, drain, and then dye at a boil in 3 lb. 4 oz. bichromate of potash in fresh water; rinse, and dry.

(2) Fast red, 11 lb.—Boil 2 lb. 3 oz. good cutch in water; let it settle; dissolve in the clear liquid 3½ oz. blue vitriol. Work the yarns for 1 hour at 212° F. (100° C.); wring out, and make up a fresh boiling beck with 4½ oz. chromate of potash. Work for ¼ hour, and rinse. Boil 3¼ lb. sumach in water; work the yarn in the liquid for ¼ hour at 190° F. (88° C.); lift; dissolve in the liquid 2¾ oz. tin crystals. Enter again, work for ¼ hour, and wring out. Make up a fresh beck with 2 lb. 3 oz. peachwood, and 8¾ oz. alum, and work in this for 1 hour at 99° F. (37° C.).

(3) Dark, 60 lb.—Boil 18 lb. cutch, and 2 lb. blue vitriol, until dissolved. Add this to a hot water; give 3 turns, and let steep all night. Give one turn in the morning, and wring up. Dissolve 2 lb. chrome; add this to a hot water; give 2 turns, and wring up. Boil 2 lb. fustic extract and 2 lb. logwood extract till dissolved; add this to a hot water; give 4 turns, and lift; add 4 qt. copperas, and give 3 turns more. Wash in cold water, and dry.

(4) Light Blonde.—Boil 6 lb. cutch and 6 oz. blue vitriol till all is dissolved. Add this to a hot water; give the yarn 3 turns; let steep all night; give 1 turn more in the morning, and wring up. Add 1 lb. alum to a hot water; give 3 turns, and lift. Boil ½ lb. turmeric and ½ lb. extract of logwood together, and add this to the same liquor. Give 4 turns; wash in cold water, and dry.

(5) Bismarck, 100 lb.—Steep the yarns overnight in a decoction of 20 lb. sumach. Wring, and pass into a boiling bath, containing the colour previously dissolved in boiling water.

For darker shades, pass the cotton from the sumach beck into a cold beck of 6 lb. copperas, and let steep for ½ hour; rinse, and return to the sumach beck for ½ hour, and dye as above.

(6) Cinnamon, 10 lb.—Take through a catechu beck, marking 4° Tw., at a heat of about 180° F. (82° C.); give about 4 turns. Enter into a chrome beck at 1½° Tw.; give 3 to 4 turns and wash. Enter into a water containing 30 gal. fustic liquor; give 3 to 4 turns, run off, and make up a fresh beck with 35 gal. sapan liquor and ¼ lb. annatto, previously dissolved. Give 3 to 4 turns; lift; add to the beck 1 gal. alum solution at 8° Tw.; give 3 to 4 turns; lift, rinse, and dry.

(7) Madder, for 10 pieces of 60 yd. each.—Pad the cloth in 6 gal. red liquor and 1 gal. iron liquor, to which about 6 gal. water have been added. Dry, and age for about 24 hours, when it is ready for dyeing. Run the pieces now through boiling water, in which chalk is suspended. Wash in the fly, rinse, and enter into a dye beck of 40 lb. bark, and 20 lb. madder. Dye for 1 hour at 170° F. (77° C.); wash and finish. Yarns may be dyed in a similar manner.

Chocolate, 11 lb.—Work the yarn for ½ hour at 167° F. (75° C.) in a beck of 8¾ oz. prepared catechu; lift, and take 5 to 7 times through a fresh beck at the same heat, made up with 1¼ oz. chromate of potash. Lift, and top in a fresh beck with ⅒ oz. magenta, 16 gr. extract of indigo.

Claret, 11 lb. yarns.—Make up a beck with 17¼ oz. prepared catechu, and work the yarns in it for 1 hour. Wring, and steep for ½ hour in a hot beck of 6½ oz. chromate of potash; take through cold water, and wash for ½ hour in a beck of 3¼ lb. sumach at 190° F. (88° C.). Dye in a cold beck with 1¾ oz. magenta, lift, add to the beck 8¾ oz. alum and the decoction of 2¼ lb. logwood. Enter again, work in the cold beck; lift, and add, according to shade, ⅓ to 1¾ oz. chromate of potash; re-enter, and work to shade.

Drabs.—(1) Light, 60 lb.—Boil 6 lb. solid extract of peachwood till dissolved; add the solution to a sufficient bulk of warm water; give the yarns 5 turns; lift, and add $1\frac{1}{2}$ pints black liquor (acetate of iron). Give 3 turns more; wash in cold water, and dry.

For a medium shade, the process is similar; but double the quantity of black liquor is taken.

For a dark drab, boil 6 lb. cutch till dissolved; add to hot water, and work the yarns in it 5 turns. Run off the liquid, and wring out the yarns. Dissolve $1\frac{1}{2}$ lb. peachwood extract; add this to a warm water; work 5 turns; lift, and add 1 qt. black liquor; give 3 more turns; wash, and dry.

If a yellower shade is wanted, a little fustic is boiled with the peachwood; if redder, a little alum is used with the peachwood; and if browner, a little Bismarck brown.

The shades produced may also be varied by topping with aniline colours in small quantities.

(2) Silver, 60 lb.—Dissolve 2 oz. logwood extract; add the solution to a warm water; give the yarns 10 turns; lift, and add $\frac{1}{2}$ pint black liquor (acetate of iron), and give 4 turns more. Wash in cold water, and dry.

Greens.—(1) Methyl, 11 lb.—Dissolve in boiling water $7\frac{1}{10}$ oz. tannin; lay the bleached cotton overnight in the hot solution; wring out; dye in cold water with a solution of the colour according to shade. Wring out, and dry in the dark without washing.

(2) For 22 lb.—For lighter shades, bleach well, and work in warm soap beck, to remove chlorine. Enter into a boiling lye of curd-soap, and wash out in cold water. Make up a cold dye beck with 3 parts colour to every 100 of cotton, give 5 to 6 turns, and let steep overnight. Dry the next morning. If the shade is not full enough, take through the tannin beck, and dye again to shade.

For yellower tones, dye the cotton first a yellow, with fustic and alum, and then dye cold with the green. It must be remembered that this colour is turned to a violet shade by heat.

(3) Malachite.—This can be dyed in the same manner as methyl green; but it is not sensitive to heat, and admits, if required, of the presence of small quantities of acids.

(4) Cœruleine.—This colour dyes dark-green shades, though its name would lead us to expect sky-blues. For dyeing cotton, 2 lb. 3 oz. of the colour should be stirred up with twice its weight of bisulphite of soda at about 78° Tw.; the mixture may stand for some hours before it is added to the dye-beck.

The cotton-yarns to be dyed are mordanted by passing alternately through chromate of potash and bisulphite of soda. The necessary quantity of colour, according to the shade required, is then added to cold water; the yarn is entered, and the heat is gradually raised to a boil. The shade obtained bears soaping and exposure to air, as well as do the alizarine colours.

(5) Dark, 50 lb.—Steep for 6 hours in a decoction of 10 lb. sumach; wring, and enter into a fresh cold beck made up of 3 lb. alum, 9 oz. methyl green of a bluish shade, and 2 pails fustic liquor. Turn quickly, raising the temperature to 150° F. (66° C.); when the dye is exhausted, dissolve 3 to 4 oz. copperas in the same liquor, and give 3 to 4 turns, to sadden.

(6) Ordinary, 100 lb. yarn.—Dissolve 10 lb. nitrate of iron, and 1 lb. tin crystals; work the yarn in this solution cold; give 5 turns, and wring. In another beck dissolve 6 lb. yellow prussiate; give the yarn 5 turns in the cold solution; wring, and pass back into the nitrate of iron, and thence back into the prussiate beck, to which 2 lb. alum have been added; give 5 turns in each, and rinse.

Boil 40 lb. bark for 1 hour, strain into a tub, add 1 lb. sugar of lead, well dissolved; when all is well mixed, enter the yarn at 180° F. (82° C.), and work for $\frac{1}{2}$ hour; lift, wring, and pass through another beck containing 2 lb. alum, and 2 lb. indigo paste. Rinse, and dry.

(7) Boil 25 lb. fustic in a bag, and add to the liquor $2\frac{1}{2}$ lb. verdigris previously dissolved in vinegar and hot

water; cool the dye; enter the yarn, which has been prepared overnight in a decoction of sumach; handle it well, and heat up to a boil, working for ½ hour. Cool it and enter it into another beck, containing a decoction of 10 lb. logwood. Heat up to a boil, and work ½ hour; take out, rinse, and dry.

If blue vitriol is used instead of verdigris, an olive green is obtained.

(8) Chrome.—Give the yarn a blue bottom in the vat; take through dilute sulphuric acid, and wash very well. Take through sugar of lead solution at 6° Tw., then through caustic soda lye at 2° to 3° Tw., and wash off. Enter into bichromate bath at 2° Tw. Each operation requires 5 to 6 turns. Wash off and dry.

Greys.—(1) Light, 11 lb. yarn.—Boil 4½ oz. sumach in 87 pints water; in this steep the yarn for 1 hour, turning frequently; *lift, and add to the beck a decoction of* 4½ oz. copperas; stir; re-enter, give 5 turns, steep for 15 minutes, and give another turn; let steep again, and turn once more; lift, and take through water. Wring out, and dry.

(2) Medium Mode, 11 lb.—Add to 44 qt. water at 100° F. (38° C.) a decoction of 17¼ oz. sumach, 8¾ oz. logwood, and 4¾ oz. prepared catechu. *Steep for 1 hour.* Add 4¾ *oz.* nitrate *of iron* at 75° Tw.; re-enter, give 10 turns, and enter into fresh water at 100° F. (38° C.) with 2½ oz. chromate of potash.

(3) Light, on 60 lb. cotton pieces.—Boil 1½ lb. solid extract of logwood and ½ lb. extract of bark in sufficient water. Run the pieces 6 to 8 times through; press; and take through a fresh beck of 5 *lb. copperas*; rinse; and calender *out of the following mixture*:—45 lb. farina, 3 lb. wax, 6 lb. coco-nut oil, boiled to a stiff paste. Press, and dry.

(4) Fast, 22 lb.—1st operation: 35 fl. oz. olive oil, and 2 lb. 3 oz. soda crystals. Work in this mixture at a boil for 30 minutes; wring and dry. 2nd operation: Grind 44 lb. coal very fine; add 22 lb. soda crystals, and 17½ *pints of* water at a boil. Mix the whole very well, and let steep *for some hours.* Then boil for ½ hour in 15 times the quantity of water; strain; and work *the cotton in the hot liquid for* ¼ *hour,* airing well; pass 5 times through the same liquid, and wring each time. Wash first in luke-warm water, then in cold water; wring, and dry. 3rd operation: The dry cotton is passed into weak size, to which a little emulsive oil has been added. Wring, and dry. This grey resists soap, acids, and chloride of lime.

(5) Stone-shade, 25 lb.—Boil 25 lb. *sumach,* and 1 lb. fustic; enter the yarns into the decoction, to which a sufficient quantity of water has been added; give 5 turns; wring; and enter into a cold beck, with a solution of 1 lb. copperas (protosulphate of iron, or ferrous sulphate), and ¾ lb. blue stone (copper sulphate). Give 5 turns, rinse, and dry.

Olive, 11 lb.—Extract 8¾ *oz.* sumach in *boiling water; enter the yarn into* the clear liquid; let steep, and make up a fresh beck, with the same weight of copperas. Wring out the yarn and enter into this second beck, working for ¼ hour. Wring, and enter into a fresh beck of red liquor at 1½° Tw. Give 12 hours; heat to 144° F. (62° C.); wring out; and work for ½ hour in a decoction of quercitron bark.

Oranges.—(1) Full Lead, 60 lb.—Boil 12 lb. sugar of lead in 12 gal. clear lime-water till dissolved; add this to enough cold water. Work yarn 5 turns, and wring. Repeat this process twice in the cold liquors, wringing after each time. Get a clear lime-water up to the boil, and give the yarns 5 turns in it, working very quickly. It is very important that the lime-water should be boiling, to keep the yarns level. Wash off in warm water with a little soap, and dry.

This colour, like all others in which lead is an ingredient, will be darkened and spoiled if exposed to fumes of sulphuretted hydrogen.

(2) Annatto, 60 lb.—Boil 6 lb. concentrated annatto with 2 lb. soap, and 2 lb. common soda, till completely dissolved; add this to boiling water. Work the yarns 5 turns; wash in cold water, and dry. This colour may be modified

by topping with small quantities of magenta, &c.

(3) Aniline, 60 lb.—Boil 3 lb. tannic acid, and add the solution to warm water. Work the yarns 5 turns and wring. Add 3 qt. nitro-muriate of tin to enough cold water, and mordant in the mixture. Wash well in cold water, with a little soap in the last water. Dissolve 12 oz. aniline orange, and add the solution to warm water. Give 5 turns, wash, and stove-dry.

Purple, 10 lb.—Prepare in stannate of soda at 10° Tw.; pass in dilute sulphuric acid at 2° Tw.; and give 2 washings in clear cold water. Fill up a tub with 30 gal. logwood liquor; give 4 to 5 turns; lift; and add 4 qt. alum solution, and ½ pint double muriate of tin; re-enter, and give 3 to 4 more turns. Wash off; and prepare another beck with 30 gal. logwood liquor, and 10 gal. peach or sapan-wood liquor; re-enter, and give 3 to 4 turns; add ½ pint purple spirit, and 4 qt. alum water. Give 5 to 6 turns; wash and dry.

Reds. (1) Eosine. — These shades range from a cherry-red to a true rose, and have not the violet cast of magenta. For a more bluish shade, steep in a bath of curd soap at 144° F. (62° C.); work for ½ hour; rinse; and work for the same length of time in subacetate of lead (basic sugar of lead) at 4° Tw. Rinse, and dye in a bath of eosine at 144° F. (62° C.). Soft soap must be used throughout the process. If yellower tones are required, alum is added to the sugar of lead beck, more or less according to the shade intended.

Eosine is also sometimes fixed upon cotton by mordanting in red liquor, and then passing through water in which chalk is suspended, when hydrate of alumina is deposited on the fibre.

(2) Rose Bengale.—This beautiful colour is fixed upon cotton as follows: Work the yarns for 1 hour in water, to which has been added 5 per cent. of the emulsive oil used for Turkey-red dyeing. Dry; steep for 2 hours in cold red liquor at 3° Tw.; and enter into the colour bath, which should contain ½ oz. of the dye, and ¾ oz. of the red liquor, to every 2 lb. 3 oz. of cotton. Work for 1 hour at 112° to 140° F. (44° to 60° C.).

The red liquor in question is made by dissolving 3¼ oz. alum in 17¼ oz. water, and adding 1⅞ oz. acetate of lime, previously dissolved in the same bulk of water. It is allowed to settle; the clear is drawn off, and set at 3° Tw.

(3) Coralline, 11 lb. yarn. — Make up a hot beck with a decoction of 2 lb. 3 oz. turmeric. Work for ¼ hour; take out, and rinse in cold water; prepare another beck with 1¾ oz. soap, and 3½ oz. olive oil, the heat being 86° F. (30° C.); work the yarn in this for ¼ hour and wring. Then dye in a cold solution of soluble red coralline, to which a trace of acetic acid has been added. The quantity of acid is greater or less, as a more or less yellowish shade is required.

(4) Boil in water 4¼ oz. white starch, and 4¼ oz. white glue. Enter the cotton in this at 86° F. (30° C.); work for ¼ hour; rinse, and dye in a coralline beck at 86° F. (30° C.), as already described.

(5) Coralline and Aurine, 11 lb.—Aurine dyes shades more inclining to orange than coralline. Boil 2 lb. 3 oz. sumach, or 6⅛ oz. tannin, in water, and soak the tannin all night in the clear hot liquid. Wring out next morning, and enter into a fresh beck of 17¼ oz. good glue at 122° F. (50° C.). Wring out, and dye to shade in a cold solution of coralline. Wring again, and dry, without rinsing, in a room where the air is impregnated with ammonia. The cotton, if desired, may be grounded with turmeric and annatto, and merely topped with aurine.

(6) Galleine.—Galleine dyes deep and very solid reds. The yarns are mordanted in chrome alum, or by alternate passages through chromate of potash and bisulphite of soda. The requisite quantity of galleine is then placed in a bag, and suspended in a beck of cold water; the yarn is entered, and the heat is gradually raised to 212° F. (100° C.). The goods are then taken out, and the colour is developed by hot soaping.

(7) Colours derived from resorcine, such as the eosines, phloxine, &c., may be fixed in the following manner:—

The yarns are soaped hot with curd-soap for 1 hour, and wrung without rinsing. A solution is then made of 8¾ oz. alum in 35 fl. oz. water, and diluted to 17½ pints; 1¾ oz. soda crystals are then added; the whole is allowed to settle, and the clear is drawn off. The cotton is steeped in this liquid, and kept at a boil for 10 to 12 hours; it is then passed into a bath containing 17½ pints water, and 6¾ to 10¼ oz. emulsive oil, such as is used in Turkey-red dyeing. Before the oil is added to the bath, it should be very well shaken up with 35 fl. oz. water. The cotton is steeped in this liquid for 1 hour; then wrung, and dried. The dye-beck is then made up as follows:—17½ pints pure water, such as condensed-steam water, 7 fl. oz. red liquor at 7° Tw.; and the needful amount of colour. The dyeing is begun at 122° F. (50° C.), and the beck is gradually raised to 190° F. (88° C.). The goods are allowed to steep till the bath is exhausted; then wrung without rinsing, and dried. The red liquor is prepared by dissolving 4¼ oz. alum in 8¾ fl. oz. boiling water, and adding a solution of 3⅜ oz. sugar of lead in an equal bulk of water. The two solutions are mixed, allowed to settle, and strained; the clear liquid is set at 7° Tw.

(8) Scarlet on Cotton, 100 lb.—Steep overnight in a decoction of 40 lb. sumach. Lift, and wring; enter in a bath of oxy-muriate of antimony at 3° Tw. Give 3 turns quickly; steep for ¾ hour, turning occasionally. Lift, wash well, wring, and enter into a colour-beck made up with 10 oz. "extra scarlet" (of Sehlbach & Co.), and dye to shade at 110° F. (43° C.).

(9) Saffranine Scarlet, 60 lb. yarn.—Boil 10 lb. sumach; enter yarns; give 6 turns; let soak for 1 hour, and wring, enter into a fresh cold beck of nitro-muriate of tin at 2° Tw., give 6 turns, wash, first in warm, and then in cold water; wring well, and enter into a beck of 10 lb. turmeric. Finally, make up a beck with ½ lb. saffranine; enter yarns at 50° F. (10° C.), and raise the temperature to 120° F. (49° C.), turning continually. Wring, and dry.

(10) Pink, 50 lb. yarn.—Dissolve 5 lb. Glauber salts, and 4½ oz. "erysine" (of the Berlin Aktien Gesellschaft). Enter yarn at 120° F. (54° C.); give 5 turns quickly, and dye to shade, gradually raising the temperature to 140° F. (60° C.) To ensure even shades, it is better to add only half the erysine at first; and the rest, previously dissolved, by degrees.

(11) Magenta Ponceau, 10 lb.—Boil 2 lb. turmeric, strain, and steep the cotton in the liquid for 4 to 5 hours. Wring, and take through cold sours, containing about 10 oz. muriatic acid; rinse well, and handle for 10 minutes in lukewarm water, containing 10 oz. starch, which has been boiled up to a paste with 1 oz. glue. Lastly, dye to shade in a fresh magenta beck. Magenta ponceaus and scarlets, even if the yellowest shades of the dye are taken, are never so satisfactory as those got up with eosine, saffranine, and other coal-tar colours, free from the violet tone of magenta.

(12) Alizarine Red.—Mordant in cold red liquor at 7° Tw. for 2 hours with frequent turning. Lift, wring, and air for 24 hours. Enter into a fresh beck, and dye at 212° F. (100° C.) with a solution of artificial alizarine.

(13) Cochineal Scarlet, 10 lb.—Boil 1 lb. annatto in a solution of 10 oz. potash for 20 minutes; cool a little; enter the cotton, work for 1 hour, lift, wring, and wash. Enter for ½ hour in a beck of permuriate of tin, marking 8° Tw., to which 2 oz. of tin crystals have been further added; lift, wring, and dye in a decoction of 1¼ lb. cochineal, beginning at a hand-heat, and gradually raising the temperature.

(14) Saffranine Rose, 11 lb.—Mordant with a decoction of 2 lb. 3 oz. sumach, or a corresponding smaller quantity of pure tannin, which is preferable. Dye in a clear solution of saffranine. If a shade verging towards a bluish-red is required, add to the sumach beck, before mordanting, 1¾ to 2¼ oz. tin crystals. Saffranine may also be fixed on cotton by means of red liquor, or soap.

(15) Safflower Pink, 60 lb. bleached yarn.—Add 1½ pint carthamine (extract of safflower) to the needful quantity of water. Work the yarns for 5 hours, giving a turn every ½ hour, and keep them in the liquid till all the colour is taken up. Wash off in 3 cold waters, adding 1 lb. cream of tartar to the last. Then dry, preferably by means of a current of cold air in the dark.

(16) Safflower Rose, 60 lb.—Work as above, but use double the quantity of carthamine, and take a longer time.

(17) Common scarlet, 60 lb.—Boil 6 lb. sumach, and add decoction to hot water. Work yarns 5 turns, and wring; mordant in a tin solution (red cotton spirits). Wash in two waters, and wring up. Boil 18 lb. peachwood, and 18 lb. fustic, ground, and add the decoction to hot water. Work the yarns 10 turns, and raise with 1 lb. alum. Wash in cold water, and stove. For lighter shades, the sumach may be dispensed with, and turmeric may be used in place of fustic.

(18) Barwood Red, 10 lb.—Steep for 5 to 6 hours in a decoction of 2 lb. sumach, to which a very little sulphuric acid has been added, turning from time to time. Wring out, and work in barwood spirits at 2° Tw. Wring, and enter into a beck of water at 200° F. (93° C.), containing 10 lb. rasped barwood; and work to shade at a boil.

(19) Turkey-red, with Artificial Alizarine.—The pieces are twice treated with 1⅝ oz. soda-ash a piece, each time for 18 hours; wring. Pad in oil at 160° F. (71° C.); hang up for 4 hours at 169° F. (76° C.). In padding, the lower roller should be dressed, and the upper not. Pad 5 times in the same oil bath, with both rollers dressed. After each padding, hang up at 169° F. (76° C.). Pad in potash lye at 6° Tw. at 90° F. (32° C.). Pad in potash at 8° Tw., same heat. Pad in potash at 5 Tw., same heat. Pad in potash at 3° Tw., same heat. After each padding, hang up at 160° F. (71° C.). Pass through potash at 4° Tw., heated to 107° F. (42° C.). Extract the liquor, and take care that the pieces do not touch cold water. Hang up for 4 hours at 160° F. (71° C.). Pass into the following beck at 122° F. (50° C.):—2625 pints water, 17¼ oz. potash. Wash, and dry. Formerly, when the subsequent dyeing was performed with madder-root, there followed here the "galling" process—a treatment with tannin, which is no longer required, since artificial alizarine has come into use. The pieces are passed at once to the alum-bath, which is thus made up:—To 110 lb. crystallized alum, take 33 lb. soda crystals, and mix the solutions in water, stirring diligently. The clear liquid is finally set at 6½° to 7° Tw. The cotton is mordanted in this liquid for a day, and is then carefully washed, and wrung out, and is now ready for the dye-beck. To 110 lb. cotton are taken about 14 lb. 6 oz. alizarine (at 10 per cent.), and 17¼ oz. pure tannin. Raise very slowly to a boil during 2 hours, and keep up the boiling heat for another hour. The "cleaning process" (*avivage*), a treatment with soap and tin crystals, is not required, when working with good artificial alizarine. The cotton is at once bloomed with curd-soap, and a little annatto. It is to be remarked that if the water contains no lime, 3½ oz. of chalk should be added to the dye-beck for the above quantity of cotton. The oiling process is considerably simplified and abridged, by replacing the ordinary emulsive oil with the compound invented by Dr. Müller-Jacobs—a mixture of sulpho-ricinic and sulpho-pyroterebic acids in combination with ammonia. A single passage through this mordant supersedes the 5 successive oilings formerly employed. A small quantity of the compound is recommended to be added to the dye-beck.

Violets:—(1) Gentiana, 11 lb.—Boil 2 lb. 3 oz. sumach, or 6⅙ oz. tannin, in water, and steep the yarns overnight in the clear solution. Wring up next morning, and dye in a beck at 165° F. (74° C.), containing 9 oz. gum arabic, adding more or less of the dissolved colour, according to shade. Wring, and dry.

(2) Make up a beck at 122° F. (50° C.)

with 80 gr. tannin for each 2 lb. 3 oz. cotton, and turn well for 4 to 5 hours. Wring, and enter into the colour beck at 110° F. (43° C.), adding 775 gr. acetic acid for 11 lb. cotton. Wring, and dry.

(3) Medium, 100 lb. — Mordant yarns in stannate of soda at 8° Tw.; sour at 1½° Tw. with dilute sulphuric acid; wash off with cold water, and dye with ¼ lb. aniline violet according to shade. Heat up to about 160° F. (71° C.).

Yellows: (1) On 11 lb.—Dilute red liquor to 6½° Tw., and steep the clear yarns overnight in the cold. Extract 4 lb. 6 oz. quercitron bark in boiling water, let cool down to 167° F. (75° C.), and dye to shade. If a brighter shade is desired, add to the bark liquor 1¾ oz. tin crystals.

(2) Fast, on 60 lb.—Boil 6 lb. brown sugar of lead in 6 gal. water till dissolved; add it to sufficient cold water. Work the yarns 5 turns, and wring. Dissolve 2 lb. bichromate of potash, and add it to sufficient cold water. Work 5 turns, wash twice in cold water, and dry.

Encaustic Colours. — Encaustic colours are the various metallic oxides given in the following list. When more than one substance is used for colouring, the proportions must be varied to suit the tint required. For violet, use iron or manganese with soda: for purple, chloride of gold with tin and chloride of silver; for black, iron, manganese, uranium, and iridium; for blue, cobalt, carbonate of cobalt, smalt, or silicate of cobalt. Zinc will brighten blue colours. For indigo, use the materials employed for both violet and blue; for turquoise, use copper with soda, or cobalt with zinc and soda phosphate; green may be obtained with copper, either with or without antimony, or by chrome with cobalt; for bronze green, use nickel. Zinc, or carbonate of zinc, will brighten this colour. For olive green, use nickel with cobalt; for yellow, use antimony with potash, titanium, chromate of lead, and chromate of barium. Zinc will brighten this yellow. For buff, use the materials for yellow, with iron, sepia, sienna, ochre, and umber; for orange, use uranium, or the sulphide of antimony with iron; for red, use iron, chromate of iron, sulphate of copper, and ochre; for carmine, chloride of silver; for pink, iron and chrome, with potash; for brown, use iron, chromate of iron, manganese, with or without cobalt, ochre, and hammer cinder; for grey, use iron, cobalt, iridium, platinum, titanium; for white, white clay and 5 per cent. tin oxide. The colouring oxides are used in quantities of 5 to 10 per cent., sometimes 15 to 20 per cent. No definite rule can be given for quantity. Some of these oxides act as fluxes, and great skill must be used in their employment, in order to prevent the melting of the tile.

Feathers.—(1) The feathers should be soaked in solution of ammonium or sodium carbonate, whereby they are rendered less liable to break or bend; after being dyed, they should be dried in a current of warm air. Feathers may be dyed black in the following baths:—(*a*) 100 pints water, 1 lb. ignited sodium carbonate; (*b*) ferric nitrate at 70° B.; (*c*) 2 lb. logwood, 2 lb. quercitrine. ½ lb. feathers is digested in *a* at 30°; the feathers are then washed with warm water, and soaked in *b*. After another washing they are boiled in c, until of a deep black colour; they are then dipped in an emulsion formed by agitating oil and potassium carbonate together, and dried by gently swinging them in warm air.

(2) Feathers may be dyed brown by first treating them with catechu and then with potassium chromate; they can be dyed directly with aniline colours, and can be bronzed by painting with aniline violet dissolved in alcohol at 90 per cent. (*Ding. Pol. Jl.*)

Flowers, Grasses, and Mosses. —Dyeing is especially used for the red Xeranthemum annuum fl. pl., red asters, and all kinds of ornamental grasses. Mix 10 parts fresh water with 1 of good nitric acid, plunge the flowers in, shake off the liquid, and hang them up to dry. In this way, Xeranthemums, which should be cut when entirely open, will acquire a beautiful bright red tint; while grasses only become a little pale red on the tops, but will keep afterwards for many years, and may, if needed, be coloured otherwise at any time. Asters generally, when treated in this way, are not so fine as if dried in sand, or smoked with brimstone. To colour flowers and grasses blue, violet, red, scarlet, and orange, use the different kinds of aniline: for yellow, use picric acid, and for bright scarlet, use borax. The aniline dye should be dissolved in alcohol before it is fit for use, in which condition it should be kept in well-closed bottles until it is required. It may also be purchased in a dissolved condition of any respectable chemist. To colour by means of aniline, take a porcelain, or any other well-glazed vessel, pour in some boiling water, and add as much dissolved aniline as will nicely colour the water. According to the quantity of aniline used, the colour of the flowers will become more or less bright. After the water has cooled a little, plunge in the flowers or grasses, and keep them in it till they are nicely coloured; then rinse in cold water, shake off the liquid, and hang them up in the open air to dry. To obtain a fine blue, take aniline bleu de lian, boil the colour with the water for 5 minutes, and then add a few drops of sulphuric acid before using. For violet, use 1 part aniline violet and 1 of aniline bleu de lian; for red, aniline fuchsin; for scarlet, 1 part aniline fuchsin and 1 of aniline violet; for orange, aniline d'orange; for lemon colour, picric acid, which should be dissolved in boiling water, and then thinned with a little warm water. Dip in the flowers, but do not drain off the liquid. All kinds of ornamental grasses can be thus coloured (especially Stipa pennata and Ammobium alatum), white Xeranthemums, and most other everlasting flowers, Immortelles, however, as well as the other kinds of Helichrysums, must be treated differently; their natural yellow colour must first be extracted by dipping them in boiling soap-water, made with Italian soap, and afterwards dried in an airy, shady place. The flowers generally become closed when thus treated, and should be placed near an oven, and subjected to the influence of a dry heat, when they will soon reopen. This is very important, if they are intended to be coloured; if not, they will remain fine pure white immortelles. Most immortelles, however, are coloured bright scarlet by means of borax, which gives a beautiful colour; but it does not keep well, and becomes gradually paler. For this purpose, dissolve as much borax in boiling water as will colour it nicely; when cool, dip the flowers, but do not allow them to remain in after they have taken the colour; if kept in too long, they will not again open their flowers. The chief point in every mode of colouring immortelles is to place them first in a dry, warm atmosphere, where they will open their flowers well; and, after colouring, they should again be exposed to heat, by which means they will nearly always reopen them. Very nice-looking immortelles are also produced by colouring only the centre of each flower scarlet, which is done very rapidly with borax, by means of a small pencil or a thin wooden splinter, dipped into the colour and afterwards applied to the centre. This is generally done by little children in those establishments in Germany and France which supply the trade with everlasting flowers. Finally, a very cheap and a very good recipe to colour ornamental grass and moss a beautiful green:—If a dark green is required, take 2 oz. boiling water, 1 oz. alum, and ½ oz. dissolved indigo carmine; plunge the moss or grass into the mixture, shake off the liquid, and dry in an airy, shady place. In the winter, however, they should be dried by means of fire-heat. If a light green is required, add to the above mixture more or less picric acid, according as a more or less light shade is required. (*Eng. Mech.*)

Hats.—The fulling-stock may be made the vehicle for dyeing or staining all fancy colours, as drabs, beavers, slates, mouse, tan, rosy drabs, and many others. Some makers partially dye, and then complete the staining in the stocks.

Beaver.—(1) Take 1¼ lb. copperas, 1 pint pyrolignite of iron diluted with boiling water, 4 oz. Hofmann's aniline blue, 4 oz. indigo extract (free from vitriol, or this will turn it green), for 1 doz. hats.

(2) For the fulling-stocks, for 24 doz. 3-oz. bodies: 1 lb. common graphite (black lead), 3 lb. Venetian red, 1 gill indigo extract.

(3) Light: 2 lb. red-lead, 1 oz. indigo extract, 1 lb. *common* graphite, 2½ lb. terra castle.

Cream colour for 24 doz. 3-oz. bodies: 2 lb. red lead, 2 lb. common terra castle, 2 gills indigo extract in liquor, 3 gills orchil.

Fawn colour: 1½ lb. burnt sienna ground fine, ¾ lb. burnt umber, ¼ gill orchil, ¼ gill indigo extract in liquor.

Mouse colour: 3½ lb. common graphite (black-lead), 2½ lb. best terra castle, 2½ gills indigo extract in liquor, 4 gills orchil, 8 oz. red-lead.

An ordinary drab for soft hats: ¾ lb. common graphite, ¾ lb. best ditto, 3 gills orchil, 2 gills indigo extract; put the graphite into a pan, cover with water, and let down with sulphuric acid at 30° Tw.

Rose: 2¾ lb. common graphite, 2 gills indigo extract in liquor, 5 gills orchil.

Slate: 4 lb. common graphite, 4 gills indigo extract, 3½ gills orchil.

Cinnamon: 3½ lb. red-lead, 2½ lb. best terra castle, 2½ oz. picric acid, ½ gill indigo extract, 3 pints orchil. The picric acid is first dissolved in hot water, and the other ingredients are added.

General Hints.—To give the best results in fine fur hats, all the hoods should be shaved on a lathe before proofing. Many of the best makers assert that this class of goods will retain better colours by being mordanted before placing in the logwood bath. (Spons' *Encyclopædia.*)

Horn.—(1) After having fine sand-papered the horns, dissolve 50 to 60 gr. nitrate of silver in 1 oz. distilled water. It will be colourless. Dip a small brush in, and paint the horns where they are to be black. When dry, put them where the sun can shine on them, and you will find that they will turn jet black. When done, polish off. (2) By boiling in infusions of various-coloured ingredients, and is done to imitate tortoiseshell. Mix together pearlash, quick-lime, and litharge, with a sufficient quantity of water, and a little pounded dragon's blood, and boil them together for ½ hour; apply this hot; for black—iron, iron filings, copperas, with vinegar applied on this.

(3) Black. 5·5 lb. burned lime are slaked in a little water, so that a powder-like hydrate of lime is obtained; this is mixed with 2·2 lb. minium, and this mixture is formed into a thick paste with such lye as soap-boilers use, having a specific weight of 1·036. The articles of horn are placed in this solution for 24 hours; they are then taken out, rinsed off with water, dried with a cloth, brushed over with rape-seed oil, and then again rubbed dry.

(4) Black. 0·14 oz. silver are dissolved in 2·1 oz. nitric acid (aqua fortis), and this solution is applied several times to the article to be stained, but it is absolutely necessary that the first coat should be entirely dry before another is applied. The articles are then burnished and made bright.

(5) Green. 0·52 oz. fine indigo-carmine are dissolved in 2·1 oz. rain-water. Then 0·175 oz. pure picric acid are dissolved in 2·1 oz. boiling hot rain-water, and both solutions are mixed together. A very beautiful, durable green colour will in this manner be obtained, and can be used for the various manipulations.

(6) Green. 0·35 oz. aniline green are dissolved in 4·2 oz. spirit of wine, and the horn to be stained is treated with this solution. All the different shades of green may be produced by adding blue or yellow stain.

(7) Green. 7 4·2 oz. copper cut up finely and gradually dissolved in 13 oz. nitric acid (aquafortis), and the articles to be stained are boiled in this solution until they have assumed a fine green colour.

(8) Purple. 17·5 oz. logwood are boiled in 4·4 lb. milk of lime, and the same method is observed as given in (9).

(9) Red. 17·5 oz. red Brazil-wood

are boiled for 1 hour in 4·4 lb. milk of lime, and filtered through a cloth. The articles of horn, ivory, or bone to be stained are boiled for 1 hour in a solution of 1·05 oz. alum in 17·5 oz. water. They are then placed in the above stain, and allowed to remain there until the desired colour has been produced. Articles stained in this manner will acquire a beautiful purple colour by dipping them in alum-water.

(10) Bright red. 8·75 oz. logwood and 8·75 oz. red Brazil-wood are boiled in 4·4 lb. milk of lime. It is applied in the same manner as (9).

(11) Tortoise-shell. A rough dough is prepared from 17·5 oz. white litharge, 2·2 lb. finely-powdered unslaked lime, 3·3 lb. soap-boilers' lye having a specific weight of 1·036. The places of the horn which are to become dark are covered with this dough, and the horn is allowed to remain in contact with the dough for about 24 hours, until the latter has become entirely dry. The horn is then cleansed with a brush.

(12) Yellow. 17·5 oz. alum, free from iron, are dissolved in 4·4 lb. rain-water. The articles are allowed to lie in this for 1 or 2 hours. In the meanwhile 7 oz. yellow berries are boiled with 4·2 oz. carbonate of potash in 2·2 lb. water for 1 hour, and then strained. The articles stained with alum are placed in this decoction, and allowed to lie in it for 1 hour. They are then taken out and dried.

Horsehair.—The horsehair is first washed in soap and rinsed.

Brown is obtained by letting lie for 12 hours in a decoction of logwood and limewater at 120° F.

Blue, violet shade, is treated as described in brown, then passed through water to which a little chloride of tin solution has been added.

For blue, the hair is mordanted in a solution of 2 parts alum and 1 tartar, rinsed and dyed in a solution of sulphate of indigo, then washed and dried.

Red.—The hair is first laid down for 1½ hours in a solution of chloride of tin, and then prepared as blue, violet shade; after rinsing, it is dyed with Brazil-wood and, alum allowed to lie in the bath for 24 hours, washed, and dried.

Ivory.—The pieces are always first polished with whiting and water, and when washed quite clean from the whiting are then prepared for the stain by a short immersion of from 3 to 5 minutes in acidulated cold water, in proportion of 1 part of muriatic acid, the ordinary acid of commerce, to 40 or 50 of water, or in an equally weak solution of nitric acid. This cleansing fluid extracts the gelatine from the surface of the ivory, and is essential to the attainment of a perfectly uniform colour. Extreme cleanliness and the absence of any grease or accidental soiling are as necessary, with which view the work in process of staining is at no time touched by the fingers, but is removed from one vessel to another by flat pieces of wood, attached to each other at one end by a flat metal spring after the form of a pair of sugar-tongs, separate pairs being kept for different colours. Subsequently to its treatment with the acid, the ivory is invariably again placed in cold water that has been boiled, before it is transferred to the stain.

(1) Place in vinegar for ¼ hour, then in Judson's dyes till the required shade is produced.

Black.—(2) Lay for several hours in a strong solution of silver nitrate, remove and expose in a strong light.

(3) Place a handful of logwood in about 1½ pints water in a saucepan, and let simmer till reduced to ¾ pint; put the ivory into the still boiling liquid, and let remain for 10 minutes; remove and lay before a fire or in an oven till well dried; afterwards polish with chamois leather.

(4) Make a decoction of 2 oz. logwood dust in 1 qt. water, and stain; dissolve 1 oz. iron sulphate in 1 qt. water; then heat the two stains in separate vessels to 100° F. (38° C.), and immerse the ivory in the logwood for 15 minutes; well wash, and put it into the iron sulphate for 5 minutes.

Blue.—(5) Immerse for some time in a dilute solution of indigo sulphate containing potash.

and s [illegible] in the proportion of 2 parts of the former to 1 of the latter, being careful to observe the same precautions as in staining red; then dip in strong solution of pearlash and water.

Brown.—(8) Alkanet root.

Green.—(9) Boil in a solution of verdigris in vinegar till the desired shade is produced.

Red.—(10) Make an infusion of cochineal in liquor ammoniæ, and immerse pieces therein, having previously soaked them for a few minutes in water slightly soured with nitric acid.

(11) Dip in the tin mordant used in dyeing, and then plunge into hot decoction of logwood, ½ lb. per gal. water.

(12) Dip in a solution of nitromuriate of tin, and then in lac, to produce scarlet; by then plunging into a solution of potash it will become cherry red.

(13) Boil cuttings of scarlet cloth in water, and add pearlash by degrees till the colour is extracted; add a little rock-alum to clear the colour, then strain. Steep the ivory in nitric acid diluted with twice the bulk of water; take out and plunge into the dye till sufficiently deep. The acid bath must not be too strong, and the ivory should be taken out as soon as the surface becomes rough; the dye bath must be warm, but not hot. A variegated appearance may be produced by covering portions with white wax, these retaining their natural whiteness.

Yellow.—(14) Saffron or turmeric. Immerse in a solution of ½ lb. alum per pint, then boil in decoction of turmeric in lime-water.

(15) 0·175 oz. picric acid are dissolved in 1·05 oz. hot water. On the other hand, 0·07 oz. concentrated sulphuric acid are diluted with 0·35 oz. hot water, and the freshly-smoothed articles are laid in the fluid, and frequently turned. They are then taken out, dried off, and placed in a solution of picric acid while this is still hot, where they remain until they are uniformly yellow. A lustre is given them by polishing with soap and water and fine whiting. (This is a very good method for colouring billiard balls yellow.)

(16) 0·35 oz. aniline yellow are dissolved in 10·5 oz. spirit of wine. The ivory is brushed over with this solution or is placed in it. If some aniline red is added to this stain, all shades of colour, from orange to bright reddish yellow, can be obtained.

Vegetable Ivory.—L. Müller finds that objects of this material may be stained by boiling them for a long time in a perfectly clear solution of the desired colouring matter. Aniline red, picric acid, or potassium dichromate, iodine green, sumach, aniline dyes, &c., may be used conveniently. The ivory must be thoroughly clean. It may be bleached by immersion for several hours in a solution of permanganate, and then in sulphurous acid.

Kid Gloves.—Reimann states that the gloves are stretched over a wooden hand, and the colour is spread upon them with a brush. The following prescriptions are given:—

Black.—The glove is washed in alcohol, and 3 times brushed over with a decoction of logwood, allowing between each brushing 10 minutes for drying; afterwards dipped into solution of iron protosulphate, and then brushed with warm water. Should the colour not prove sufficiently dark, a decoction of quercitron may be added to the logwood decoction. Instead of the protosulphate, some nitrate of iron may be used. As the leather begins to dry, it is rubbed over with talc powder and some olive-oil, and pressed between flannel. The treatment with talc and oil is repeated, and the glove then allowed to dry on the stretch-wood.

Brown.—The solution is made up of varying quantities of decoctions of logwood and Guinea-wood. For darkening, a small quantity of iron protosulphate is employed.

Russia-red.—Decoction of cochineal with a tin salt and some saccharic acid, and, if a dark tint is demanded, addition of some logwood extract.

Grey.—Brushing with decoction of sumach, and subsequent treatment with a feeble solution of iron protosulphate. Addition of logwood and yellow Brazil-wood to the sumach decoction produces a greenish-grey tint.

The aniline colours can be employed without any previous preparation of the leather. The bluish tint so greatly liked in black gloves is obtained by washing the finished article with sal-ammoniac solution. If it is required to keep the seams white, they are covered with flour-paste with which some fat has been admixed. Instead of brushes, one may sometimes use a sponge. (*Ding. Polyt. Journ.*)

Kid gloves of good quality, especially when light-coloured, are often thrown away when soiled, and made no further use of. By employing the following simple means, they might easily be dyed violet, black, or yellow, by the owner himself, and made to look almost equal to new:—The gloves are first soaked in a little hot water containing dissolved crystals of soda or potash, whichever colour may be desired, and after a 25 minutes' bath they are taken out, washed, rinsed, and wrung. When the gloves are thus cleaned, they are stretched tightly on a block, and the dye applied.

Violet.—According to the tint desired, aniline or orseille violet must be used. Apply a little of the colour by means of a brush or rag dipped in the colouring liquid. Lay on several coats of alum dissolved in water; then dry. Then apply one or two layers of the dye, which must be always hot. The kid is polished, before finally drying, with a pad made of a cork covered with a piece of woollen cloth. This is the best way of regaining the gloss.

Black.—The same means are employed throughout.

Yellow.—This requires a less complicated process—a decoction of Avignon crystals with alum. Apply several layers, and polish the kid in the way indicated above. (*Text. Manuf.*)

Simple decoction of onion peel is said to produce upon glove-leather an orange-yellow superior in lustre to any other. It is also said to be suitable for mixing with light bark shades, especially willow-bark, and as a yellow for modulating browns. The onion dye is said to fix itself readily, even upon leathers which resist colours, and colours them well and evenly. (*Chem. Rev.*)

Glove-kids are dyed in 2 ways:—(1) The skins are plunged into the dye bath; in this way all light colours are ordinarily produced, such as pearl grey, straw yellow, reddish yellow, silver grey, aquamarine, &c. (2) The skins are spread on an inclined or round table of stone or metal, and brushed over on the grained side—first with a mordant, then with a dye liquor, and lastly with a solution of mineral salt. The mordant serves to fix the colour on the surface of the skin, to prevent its striking through, to produce certain modifications of colour, and to enable any parts of the skin which yet contain fat to take colour evenly with the rest. To satisfy these conditions, the composition of the mordant is varied. Bichromate of potash, ammonia, potash, soda, and stale urine are among the most frequently employed, seldom separately, but usually in a mixture containing 2 or more. Dyestuffs of vegetable origin have always held the first place. Those most in use are logwood, Brazil-wood, the 2 fustics, several species of willow bark and of berries, indigo carmine, and indigo dissolved in sulphuric acid. Aniline colours used alone remained in fashion for a short time only, but are now usefully employed as top colours—namely, brushed in very dilute solution over vegetable colours. In this way particularly graceful shades of green, violet, and marine blue may be produced. After the mordant has been applied once or twice, and the colour 3 to 6 times, a wash containing some metallic salt is generally applied, with the object of either bringing out the special tone required, or of making the colour more lively and permanent. The so-called vitriols are mostly employed—"white vitriol" (zinc sulphate), and occasionally other salts. Before dyeing, the greater part of the flour, salt, and alum must be removed from the skins by washing with tepid water, and therefore they require a second treating with egg yolk and salt. In the case of skins which are dyed by plunging into the dye-vat, this is done after the dyeing is completed; in that of brush dyeing, before the dyeing process. After the dyeing, the skins, if dipped, are wrung out; if brush dyed, slicked out with a brass plate, to get rid of superfluous water. They are then dried in an airy room. Before staking (stretching), the skins are laid or hung in a damp cellar, or in moist sawdust. They are staked twice—once damp, and once nearly dry. Skins which are much damaged on the grain, or otherwise faulty, are smoothed with lump pumice on the flesh side, either by hand or machine. They are then dyed on this side, mostly by dipping, but occasionally with the brush, in which case the method described is slightly modified. (Spons' *Encyc.*)

Leather.—The following stains for leather are selected from the best authors on the subject:—

Blacks.—(1) ½ gal. vinegar, ½ lb. dry lamp-black, 3 lb. sifted iron rust; mix, let stand for a week; lay 3 coats on hot, and rub with linseed-oil.

(2) ½ lb. good galls, well broken, ¼ lb. logwood, 3 oz. iron sulphate; makes about 2 gal.

(3) Wet with iron liquor and rub with a piece of iron; then oil, or give a dressing of composition made by melting 2 oz. black rosin and adding 3 oz. beeswax. When thoroughly melted, take from the fire, and add ½ oz. fine lamp-black which has had ½ dr. Prussian blue mixed with it; thin with turps just before it gets too cold. Apply a coat of this with a rag, and polish with a soft brush.

(4) Ball Black. For harness leather straps, this is made of ¼ oz. isinglass, ¼ oz. indigo, 4 oz. logwood, 2 oz. soft soap, 4 oz. glue, softened, and 1 pint of vinegar; the whole is mixed, warmed, strained, and allowed to cool, when it is ready for use.

(5) Hatters' Black. This black is unequalled for finishing. It is made by dissolving 1 lb. extract of logwood, ½ oz. bichromate of potash, and 1 oz. copperas in 1 gal. water.

(6) Patent Leather Black. Mix together ½ lb. each of ivory black, purified lamp-black and pulverized indigo, 3 oz. dissolved gum-arabic, 4 oz. brown sugar, and ¼ oz. glue, dissolved in 1 pint water; heat the whole to boil over a slow fire, then remove and stir until cool, and roll into balls.

(7) Vinegar Black. This is the most simple and useful colouring liquid for the trimming shop for blacking leather straps. To make the simplest, and without doubt the best, procure shavings from an iron turner, and cover them with pure cider vinegar; heat up and set aside for a week or two, then heat again and set in a cool place for 2 weeks; pour off the vinegar, allow it to stand for a few days, drain off, and cork up in bottles. This will keep a long time, and while producing a deep black on leather, it will not stain the hands.

(8) Vanadian Black. This process is due to Sörensen, of Sweden, and he thinks that it will make black dyeing on leather easier, cleaner, and more durable than that obtained by present methods. The leathers to be treated by this process ought to be tanned with nut-galls, and consequently contain gallic acid or its derivatives, which give a black colour on treatment with salts of vanadium. The author admits as well known the compounds of gallic acid with which vanadium ought to produce a black dye, as well as the salts of vanadium which are commonly used for this purpose. It is of no importance what particular time after the tanning is chosen for dyeing the leather black. The dyeing is effected by simply applying over the surface a solution of a suitable salt of vanadium, so that the chemical reaction may take place within the texture of the leather. Thus he recommends as very efficacious a solution of the neutral vanadiate of ammonia, 1 lb. in 10 gal. water. The operation should be conducted at a moderate heat, which is

favourable to obtaining a fine black. This process is recommended in place of curriers' blacking for leathers of an open texture, as for shoes, harness, &c. It is easy to produce reserves by applying the solution of vanadium only to some particular parts of the leather, leaving the rest untouched. In saddlery a very elegant effect is produced spontaneously owing to the circumstance that the waxed thread of the seams does not take the colour, but retains its own colour, and appears as a light design upon a black ground. The operator in this kind of leather dyeing does not soil his hands. There is produced a true, penetrating, and durable dye in place of a mere superficial coating, which often requires renewal and becomes lighter with time. (*Teint. Prat.*)

(9) 4·2 oz. bruised gallnuts and 17·5 oz. green nutshells are boiled in 26·25 oz. rain-water. When the mixture has boiled 1 hour, the liquor is strained through a cloth. The leather to be coloured is first stained with the solution of iron filings, common salt, and vinegar, as given under purple, before the above decoction is applied.

Blue.—2·2 lb. elderberries are boiled with 1·05 oz. alum, free from iron, in 2·2 lb. wine vinegar, and this solution is also filtered. If leather is to be coloured blue, the decoction of elderberries is applied uniformly with a sponge. When the coating is dry, it is brushed over lightly with solution of blue vitriol in vinegar.

Browns, Russets, Reds, Yellows.—The use of russet and brown leather for reins necessitates the employment of stains of various shades in the workshop, in order that the reins or other straps may be of a uniform colour after being worked. In most cases rein leather is stained by the currier, but when worked the freshly-cut edges need to be stained to correspond with the grain. The stains used are generally made of Spanish saffron and annatto, or of saffron alone, made up in various ways, the most common and reliable being the following:—

(1) Boil a given amount of saffron in water until the colour is extracted; cut a quantity of annatto in urine and mix the two together, the proportions of each determining the shade. The more annatto used, the darker is the colour.

(2) Another manner of preparing this stain is to boil ½ oz. Spanish saffron and ¼ oz. annatto in water until the dye is extracted, to which must be added some alcohol to set the colour.

(3) To make a stain of saffron alone, boil a quantity in water until the dye is extracted; strain off, and when cold add alcohol in order to set the colour. The shade may be changed by adding oxalic acid in varying quantities, according to the colour required. The proportion cannot be given with any degree of accuracy, as the colour is a matter of taste, and can be regulated by using greater or less proportions of each article.

(4) Another saffron stain is made by boiling saffron in a small quantity of water until the colour is extracted, and reducing with urine.

In using any of these stains apply them with a cloth, and when nearly dry rub with a woollen rag slightly waxed.

(5) A yellow stain is produced by boiling fustic berries in alum water; the shade may be darkened by the addition of a small quantity of powdered Brazil-wood boiled with the berries.

(6) Another yellowish-red stain is made of Brazil-wood and yellow berries in proportion to suit, boiling them in water until the colouring matter is extracted. This can be applied to sides that have not been stained, when intended for flat reins, halters, &c., in the following manner:—

Lay the leather upon a table, and rub the flesh side with a warm stretching iron; turn it over and moisten the grain side with water, and rub with a copper stretching-iron until the leather is nearly dry; then apply the colouring matter to the grain, and rub with a copper slicker. When the leather is perfectly dry, rub the grain with a glass slicker. An edge stain is made by adding a small quantity of alum to the above-mentioned ingredients.

(7) A brown stain is made by boiling equal parts of pine and alder barks in 6 times their bulk of water until all the colouring matter is extracted, and when cold adding a small quantity of alcohol. Saffron boiled for 12 or 15 hours gives a good brown stain, to which alcohol must be added to make it set.

(8) Picric acid and water, in proportions of 1 to 10, heated to a blood heat, make a good yellow stain. Weld boiled in water also makes a yellow stain. An orange-yellow is produced by boiling fustic berries in alum water. This stain may be converted into a rich brown by washing the leather to which it has been applied, before the stain is fairly dry, with an alkali.

(9) A red stain is produced by boiling Brazil-wood in lye. If mixed with weld it produces a brownish yellow, well adapted for use on halters and bridles.

(10) An edge stain for russet leather is made by cutting 11 oz. annatto in 2 qt. urine, allowing it to stand for 24 hours, then adding 3 qt. water, and boiling until reduced to one-half the original quantity.

All stains appear to better advantage, and are rendered more durable, by being covered with a shellac varnish, which should be applied after the reins are all dry, and then finished up. The shellac should be applied with a sponge.

(11) A bright orange stain is made by mixing yellow aniline with alum water.

(12) 1 oz. oxalic acid, 1 oz. spirits of salts, 1 scr. bruised cochineal, and 1 pint boiling water, make a good brown stain.

(13) Another red stain is made by dissolving 1 oz. cochineal in ½ pint hot water, and adding 1 gill spirits of hartshorn.

(14) A bright crimson stain is alum or tin salts and a decoction of cochineal.

(15) For sole leather, 185 dr. Paris yellow, 37 dr. chrome yellow, 312 dr. pipeclay, 250 dr. alum, 250 dr. quercitron, 185 dr. sulphuric acid, 1¾ pints tragacanth solution, boiled together with 7 pints water, and the mixture, when cold, suitably applied.

(16) Brown. 17·5 oz. dried and powdered nut-shells are boiled for 1 hour in 52·5 oz. milk of lime, and strained through a cloth. This decoction is applied frequently to the leather. 4·2 oz. ground logwood, 4·2 oz. annatto are boiled in 17·5 oz. rain-water, and a solution of 0·52 oz. carbonate of potash in 2·62 oz. vinegar is added to the above decoction.

(17) A brown stain is also obtained by rubbing together upon a marble slab, 4·2 oz. umber, 0·52 oz. finest lampblack, in oil, with 17·5 oz. ox-gall.

(18) Yellow. 0·52 oz. saffron, cut in small pieces, are digested in 2·1 oz. alcohol 80 per cent. strong, for several days at a moderate heat. The solution is filtered, and applied directly to the leather.

(19) Yellow. 17·5 oz. ground yellow wood or 17·5 oz. birch leaves are boiled for 1 hour in 2·2 lb. vinegar, and the fluid is strained. The articles to be stained are first covered with a solution of 1·05 oz. carbonate of potash, with a sponge to the leather, which has first been stretched, and when this has become dry, apply the colouring liquor also with a sponge.

(20) Bright Yellow. 1·05 oz. finely-powdered turmeric and 0·52 oz. gamboge are digested at a gentle heat for a few days in 26·25 oz. alcohol 80 per cent. strong, and the fluid is then filtered. The process is the same as (19), either with or without alum or carbonate of potash.

(21) 17·5 oz. barberries are boiled in 2·2 lb. water, and the decoction is filtered. In this case also a solution of alum or carbonate of potash in water is used before applying the decoction to the article.

(22) Yellow. 17·5 oz. wold are boiled in 3·3 lb. water for 1 hour, and used in the same manner as (21).

(23) Green. 1·57 oz. verdigris and 0·52 oz. sal-ammoniac are dissolved in 8·75 oz. wine vinegar. If a small quantity of saffron extract is added to this, a yellowish-green colour, the so-called parrot-green, is obtained.

(24) Green. If leather is first coated

with a solution of Berlin blue, and then with a yellow stain, a beautiful durable green will be obtained.

(25) Violet. 17·5 oz. Brazil-wood are boiled for 1 hour in 0·44 oz. water, and the decoction is then filtered. Another solution of 4·2 oz. copperas in 8·75 oz. water is prepared, and this is mixed with the decoction of Brazil-wood. Violet stains are also obtained by mixing red and blue stains together.

(26) Red. 8·75 oz. shavings of red Brazil-wood are placed in a bottle, 2·2 lb. wine vinegar is poured over them, and they are digested for 8 days, and stirred frequently in the meanwhile. The solution is then filtered through a cloth. Meantime a solution of 1·05 oz. alum free from iron, in 8·75 oz. water, is prepared, and the above preparation of Brazil-wood is added to this under constant stirring. A very beautiful red is obtained in this manner. The shavings of Brazil-wood may also be boiled in rain-water, and this be compounded with a solution of bitartrate of potash.

(27) Cochineal. 1·05 oz. of the finest cochineal is powdered and digested in 17·5 oz. alcohol 80 per cent. strong, until it is dissolved; the solution is then filtered. More or less cochineal is taken according as the colour is required to be darker or lighter.

(28) Scarlet. 1·05 oz. scarlet berries are bruised, and dissolved in 4·2 oz. alcohol, 80 per cent. strong, and the solution is filtered.

(29) Purple. 8·75 oz. Brazil-wood shavings, or 2·1 oz. scarlet berries, are boiled in 2·2 lb. water in an earthen pot or in a bright copper boiler. The decoction is filtered and compounded with a sufficient quantity of fluid chloride of zinc to obtain either a lighter or a darker colour.

(30) Crimson. A solution of 0·14 oz. cochineal, 0·14 oz. cream of tartar, 0·42 oz. solution of zinc., is prepared. The mixture is thoroughly shaken, and the contents of the bottle are exposed to heat for 24 hours. Spirit of salammoniac is then added in drops until the desired colour is obtained.

(31) A rich permanent brown can be imparted to rein-leather by treating the hides, after they are tanned, to a bath in a liquor made from equal parts of pine and alder bark. The hides are spread in a vat, with liquor enough to cover them, where they are allowed to remain one week; they are then removed, and fresh liquor is applied. By repeating this treatment 3 or 4 times a very rich brown can be produced. Orange-brown is produced by scraping the flesh side after the hides have been removed from the vats for the last time, and sprinkling them on the scraped side with pulverized alum. As soon as each one is sprinkled with the alum, it is laid in another vat, one upon the other, and allowed to remain 24 hours; they are then moistened with the alum liquor in the bottom of the vat, and laid upon the beam and well worked, after which they are rubbed with salt and alum, and rolled up and allowed to remain undisturbed for 24 hours. This salting is repeated 3 times, after which the hides are stretched lengthwise and dried; they are then boarded and worked soft, and treated to a coat of hog's lard and train-oil on the flesh side; in about 2 days they are again boarded, and worked off with a glass slicker. This leather has a fine grain, and retains its softness for a long time.

Calf-kid.—Dyeing black is accomplished either by brushing on a table, or by "ridging" or folding, grain-side outwards, and drawing quickly through baths of the mordant and colour. To prepare them for the colour, stale urine is generally employed. A deeper colour, and one less likely to strike through the skin, is obtained by adding ¼ lb. potash bichromate to 4 gal. urine; or the following mixture may be substituted with advantage, viz. ½ lb. Marseilles soap dissolved in boiling water, 5 or 6 egg-yolks added, and the whole made up to 4 gal. with water and ¼ lb. potash bichromate. The colour used is infusion of logwood or its extract, or ⅔ logwood, which is best extracted by stale urine or old soak liquor, with addition of a small quantity of soda (1 lb. to 25 lb. dyewood). It is fixed and darkened by a wash of iron-liquor (1 of iron protosulphate in 75 cold water). After being again dried, the skins are grounded with the moon-knife, and rubbed over on the grain with a composition containing oil, wax, &c., and are finally ironed with a flat iron to give them a fine and smooth surface. Eitner gives a recipe for the gloss:—1 lb. gum-arabic, ½ lb. yellow wax, ½ lb. beef tallow, ¾ lb. Marseilles soap, 2 lb. strong logwood infusion, and 1 gal. water. The water is brought to a boil in an earthen pot, and then the soap, wax, gum, and tallow are added successively, each being stirred till dissolved before adding the next, and lastly the logwood. After boiling for an hour, it is allowed to completely cool, being incessantly stirred during the whole process. (Spons' *Encyclopædia.*)

Metals.—Before giving special recipes under the separate metals, it will be well to quote the following paragraph having a general bearing on the subject.

Metals may be coloured quickly and cheaply by forming on their surface a coating of a thin film of a sulphide. In 5 minutes brass articles may be coated with any colour, varying from gold to copper-red, carmine, and dark red, and from light aniline blue to a blue-white, like sulphide of lead, and at last a reddish white, according to the thickness of the coat, which depends on the length of time the metal remains in the solution used. The colours possess a very good lustre, and if the articles to be coloured have been previously thoroughly cleaned by means of acids and alkalies, they adhere so firmly that they may be operated upon by the polishing steel. To prepare the solution, dissolve ½ oz. hyposulphite of soda in 1 lb. water, and add ½ oz. acetate of lead dissolved in ½ lb. water. When this clear solution is heated to 190° to 200° F. (88°–93° C.), it decomposes slowly, and precipitates sulphide of lead in brown flakes. If metal be now present, a part of the sulphide of lead is deposited thereon, and according to the thickness of the deposited sulphide of lead the above colours are produced. To produce an even colouring, the articles must be evenly heated. Iron treated with this solution takes a steel-blue colour; zinc, a brown colour; in the case of copper objects, the first gold colour does not appear; lead and zinc are entirely indifferent. If, instead of the acetate of lead, an equal weight of sulphuric acid is added to the hyposulphite of soda, and the process carried on as before, the brass is covered with a very beautiful red, which is followed by a green (which is not in the first scale of colours mentioned above), and changes finally to a splendid brown with green and red iris glitter. This last is a very durable coating, and may find special attention in the manufactures, especially as some of the others are not very permanent. Very beautiful marble designs can be produced by using a lead solution thickened with gum tragacanth on brass which has been heated to 210° F. (99° C.), and is afterwards treated by the usual solution of sulphide of lead. It may be used several times.

Brass.—(1) An orange tint inclining to gold is produced by first polishing the brass and then plunging it for a few seconds in a warm neutral solution of crystallized acetate of copper. Dipping into a bath of copper, the resulting tint is a greyish green; while a beautiful violet is obtained by immersing the metal for an instant in a solution of chloride of antimony and rubbing it with a stick covered with cotton. During this operation the brass should be heated to a degree just tolerable to the touch. A *moiré* appearance, vastly superior to that usually seen, is produced by boiling the object in a solution of sulphate of copper. There are three methods of procuring a black lacquer on the surface of brass. The first, which is often employed by instrument-makers, consists in polishing the object with tripoli, and washing it with a mixture composed of 1 part nitrate of tin, 2 parts chloride of gold. Allow this wash to remain for fifteen minutes, then wipe it off with a linen cloth. An excess of acid increases the intensity of the tint. In the second method, copper turnings are dissolved in nitric acid until the latter is saturated; the objects are immersed in the solution, cleaned, and subsequently heated moderately over a charcoal fire. This process must be repeated in order to produce a black colour, as the first trial only gives a dark green. Finally, polish with olive-oil. The third method is done with chloride of platinum. In the United States and on the Continent much pains is taken to give objects "an English look." For this purpose they are first heated to redness, and then dipped in a weak solution of sulphuric acid. Afterwards they are immersed in dilute nitric acid, thoroughly washed in water, and dried in sawdust. To effect a uniformity in the colour, they are plunged in a bath consisting of 2 parts nitric acid and 1 rain-water, where they are suffered to remain for several minutes. Should the colour not be free from spots and patches, the operations must be repeated until the desired effect is produced. *(Eng. Mechan.)*

(2) Copper or brass may be bronzed in various modes. The repeated applications of alternate washes of dilute acetic acid and exposure to the fumes of ammonia will give a very antique-looking green bronze; but a quick mode of producing a similar appearance is often desirable. To this end the articles may be immersed in a solution of 1 part perchloride of iron in 2 of water. The tone assumed darkens with the length of immersion. Or the articles may be boiled in a strong solution of nitrate of copper. Or lastly, they may be immersed in a solution of 2 oz. nitrate of iron and 2 oz. hyposulphite of soda in a pint of water. Washing, drying, and brushing complete the process.

(3) To prevent the every-day rusting of brass goods the trade has long resorted to means for protecting the surface from the action of the atmosphere, the first plan of which is to force a change to take place. Thus, if brass is left in damp sand, it acquires a beautiful brown colour, which when polished with a dry brush remains permanent and requires no cleaning. It is also possible to impart a green and light coating of verdigris on the surface of the brass by means of dilute acid, allowed to dry spontaneously. The antique appearance thus given is very pleasing, and more or less permanent. But it is not always possible to wait for goods so long as such processes require, and hence more speedy methods became necessary, many of which had to be further protected by a coating of varnish. Before bronzing, however, all the requisite fitting is finished, and the brass annealed, pickled in old or dilute nitric acid till the scales can be removed from the surface, scoured with sand and water, and dried. Bronzing is then performed according to the colour desired; for although the word means a brown colour, being taken from the Italian *bronzino*, signifying burnt brown, yet in commercial language it includes all colours. Browns of all shades are obtained by immersion in solutions of nitrate or perchloride of iron; the strength of the solutions determining the depth of colour. Violets are produced by dipping in a solution of chloride of antimony or of permuriate of iron. Chocolate is obtained by burning on the surface of the brass moist red oxide of iron, and polishing with a very small quantity of blacklead. Olive green results from making the surface black by means of a solution of iron and arsenic in muriatic acid, polishing with a blacklead brush, and coating it, when warm, with a lacquer composed of 1 part lac-varnish, 4 of turmeric, and 1 of gamboge. A steel-grey colour is deposited on brass from a dilute boiling solution of muriate of arsenic; and a blue by careful treatment with strong hydrosulphite of soda. Black is much used for optical brass-work, and is obtained by coating the brass with a solution of platinum, or with chloride of gold mixed with nitrate of tin. The Japanese bronze their brass by boiling

it in a solution of sulphate of copper, alum, and verdigris. Success in the art of bronzing greatly depends on circumstances, such as the temperature of the alloy or of the solution, the proportions of the metals used in forming the alloy, and the quality of the materials. The moment at which to withdraw the goods, the drying of them, and a hundred little items of care and manipulation, require attention which experience alone can impart. (*Eng. Mechan.*)

(4) The best means for producing a black surface on brass, pinchbeck, or silver, is said to be platinum chloride, which is allowed to liquefy by exposure to the air. It is rubbed in with the finger, or, best, with the ball of the thumb. After blacking, the object is washed and polished with oil and leather. Platinum chloride is dear, but a little of it will do a great deal of work.

(5) Ordinary gas-fittings are pickled; but if you want to get a good bronze you can use either a solution of nitrate of silver or bi-chloride of platinum. The articles will require blackleading after being bronzed, and should be warmed before being dipped into the bronzing solution.

(6) A solution of nitro-muriate of platinum will blacken brass quicker than anything else; but possibly 2 oz. corrosive sublimate dissolved in 1 qt. of vinegar will act quickly enough. This solution is brushed over the brass, allowed to remain till the latter is black; it is then wiped off, and the brass cleaned and blackleaded.

(7) A very good black varnish may be made by mixing a small quantity of pure lampblack with rather thick brass lacquer, using as little lampblack as possible. Another varnish may be made by fusing 3 lb. asphaltum, and when melted add ½ lb. shellac and 1 gal. oil of turpentine.

(8) If merely wanted to black it, brush on a mixture of best vegetable black and French polish. This will give a nice dead black, or modify the deadness by the addition of polish.

(9) Make a strong solution of nitrate of silver in one dish, and of nitrate of copper in another. Mix the two together, and plunge the brass into the mixture. Remove and heat the brass evenly until the required degree of dead blackness is obtained.

(10) Finely powder a small quantity of sal-ammoniac and moisten with soft water. Heat the article to be coloured over a charcoal fire, and rub over with this mixture; then dry with bran and whiting.

(11) Wash the brasswork with roach alum dissolved by boiling in strong lye in the proportion of 1 oz. alum to 1 pint lye, and when dry rub with fine tripoli. Either of these processes will give to brass the appearance and brilliancy of gold.

Bronze.—As to the colouring which may be given to bronze, and which is obtained by various methods of oxidation, the following are some of the methods in vogue:—

(1) The dull colour of medal bronze is obtained by rubbing with a mixture of red ochre and blacklead applied by a brush.

(2) The antique green is obtained by washing the metal in a liquid made of 10 gr. marine salt, the same quantity of cream of tartar and acetate of copper, the whole dissolved in 200 gr. vinegar and 30 gr. carbonate of soda.

(3) The Florentine is obtained by means of green vitriol (sulphate of iron), and then rubbing with wax.

(4) The citron tint is obtained by means of red ochre mixed with lampblack and oil.

(5) The old green bronze is obtained by several dippings in acid, and subsequently with wax.

(6) Verdigris is obtained by means of sal-ammoniac, and wax afterwards.

(7) The smoke-tint is produced by annealing the object in a wisp of hay or straw, which is set on fire, and the article is burnished so that the oxide formed may penetrate the metal. The smoke of turf may be used instead, waxing afterwards, and removing the grease by turpentine so as to carry off the uneven first layer.

(8) Dark or Berlin Bronze. Cleanse the metal by dipping it first momentarily in nitric acid, then rinsing quickly in running water, and rubbing with sawdust. The bronzing dip may be prepared by dissolving in 1 gal. hot water ½ lb. each perchloride of iron and perchloride of copper. The metal should not be allowed to remain in this dip any longer than is necessary to produce the desired colour. Rinse well, dry, and polish in warm sawdust or with a rag buff.

(9) In preparing bronze medals for the Melbourne Exhibition, a rich chocolate colour was obtained by the addition of a little copper acetate, mixed with an alkaline sulphide, to the ordinary colcothar bronzing powder, by which a film of mixed copper sulphide and oxide, somewhat resembling Chinese bronze, was produced.

Gold.—(1) Gold alloys, particularly those containing copper, acquire, through repeated heatings during their manufacture, an unseemly brown or brownish-black colour, caused by the oxide of copper, to remove which they are boiled or pickled in very dilute sulphuric or hydrochloric acid, according to the colour they are to have. If we have an alloy containing only gold and copper, either sulphuric or hydrochloric acid is employed, for gold is not attacked by either of them, while the oxide of copper dissolves so easily that after the pickling the articles have the colour of pure gold, for the surface is covered with a thin film of gold. If the alloy consists solely of gold and silver, the liquid employed is nitric acid, and the articles are left in it a very short time; the acid dissolves a small quantity of silver, and the articles acquire the colour of gold. If the alloy contains both copper and silver, besides the gold, the method of pickling can be varied to suit the colour it is desired to give to it. If, for instance, it is put in sulphuric acid, the copper alone is dissolved, and the colour obtained is that of an alloy of gold and silver, for the surface consists of the two. If nitric acid were used, both copper and silver would be dissolved, and in this case the colour obtained would be that of pure gold. The articles are gently heated and allowed to cool again before boiling. The object of the heating is to destroy any grease or dust that adheres to them. If they are soldered with soft solder, they cannot of course be heated, and must be cleansed from grease and dust by first putting them in a strong lye, then washing with water and putting them in the acid. The acids are used dilute, usually in the proportion of 1 part concentrated acid to 40 of water. The articles are laid side by side in a porcelain or earthenware dish, and the dilute acid poured over them. From time to time one is taken out to see if it is yellow enough. When the proper colour has been reached, they are washed in clean water and dried. While this pickling is merely to bring out the colour of the gold, the colouring of gold has for its object the imparting to inferior goods of the appearance of fine gold. Different mixtures can be employed for colouring gold, two of which are given below as affording very good results. Mix together 2 parts saltpetre, 1 of table salt, and 6 of alum, with 6½ of water, and warm the mixture in a porcelain vessel. As soon as it begins to rise, add 1 part hydrochloric acid, and bring the contents of the vessel to a boil, stirring in the meantime with a glass rod. The articles to be coloured, suspended on hooks made of strong platinum wire, or of glass, are first dipped in sulphuric acid and then put in the slowly cooking solution last described, and moved to and fro in it. In about 3 minutes they are taken out and dipped into a large vessel of water so as to see what colour they are. If the desired shade is not yet attained, they are dipped in again as often as necessary until they have it. In the subsequent dippings they are only left in the liquid for 1 minute. Articles coloured in this way have a light yellow colour, but matted appearance. They are repeatedly washed in water to remove the last trace of the liquid, and then dried in soft sawdust that has been warmed.

Instead of drying in sawdust, they can be dipped in hot water the last time and left in there a few seconds, and when taken out the water that hangs on them will evaporate almost instantly. The second method of colouring gold alloys is by means of a mixture of 115 parts white table-salt and 230 of nitric acid, with enough water added to dissolve the salt. This is boiled down to a dry mass of salt. The salt is put in a porcelain dish, and 172 parts fuming hydrochloric acid poured over it and heated to boiling. As soon as the suffocating odour of chlorine is perceived, the articles to be coloured are dipped in, and the first time they are left 8 minutes in the liquid. In other respects the treatment is the same as above described. Articles polished previously do not require polishing again. Care must be taken not to inhale the dangerous gas; the operation must be conducted under a draught or out of doors. (*Schlosser.*)

(2) Place 4 oz. saltpetre, 2 oz. common salt, and 2 oz. alum in a plumbago crucible. Add sufficient water to cover the mixed salts. Now place the crucible on the fire and allow the mixture to boil. When this takes place, place the article to be coloured in the mixture, taking care that it is suspended by a hair. It may be left in the crucible for about 15 minutes, when it should be withdrawn, washed in warm water, well brushed with beer and a fine scratch-brush, and re-dipped if the colour is not intense enough.

(3) For small gold articles, such as a keeper or plain ring, &c., a very good plan is to place them on a lump of charcoal and make them red-hot under the blow-pipe flame, and then to throw them into a pickle composed of about 35 drops strong sulphuric acid to 1 oz. water, allowing the articles to remain therein until the colour is sufficiently enhanced. Washing the article in warm water in which a little potash has been dissolved, using a brush, and finally rinsing and drying in boxwood sawdust, completes the operation.

(4) Another colouring mixture, which has been greatly recommended, consists of a mixture of 20 gr. sulphate of copper, 40 gr. French verdigris, 40 gr. sal-ammoniac, and 40 gr. saltpetre, dissolved in 1 oz. glacial acetic acid. The articles, suspended by a horse-hair as before, are to be immersed in this mixture, withdrawn, and heated on a piece of copper until black. They are then to be placed in a pickle of equal parts oil of vitriol and water, which removes the black coating and brings up the colour. Washing in weak potash-water, rinsing and drying as before, terminates the treatment.

(5) An Indian native method.—Clean the article thoroughly by washing in hot soap and water, taking care to get rid of all greasiness and of all the soap. The natives use tamarind-water, and also the soap-nut. Prepare a paste of the consistence of soft butter by mixing the following ingredients with *quantum suf.* of pure water—viz. 1 oz. saltpetre, 1 oz. crude sal-ammoniac, 2 oz. sulphate of copper; grind each separately to a fine powder, then mix with water and form the paste. Apply this paste pretty thickly and evenly over the article to be coloured, and place while wet on ignited charcoal; warm till it *dries* and *smokes;* then immediately dip into cold water, and clean by using tamarind-water and a soft brush. If the colour is not deep enough, repeat the process. Plunge the article, whether of pure gold, alloyed gold, or gilt, into the following solution, and afterwards clean thoroughly with a soft brush and soap and water. To increase the depth of colour, plunge 4 or 5 times, cleaning after each plunge:—Powder finely 2 oz. alum, 2 oz. saltpetre, ½ oz. sal-enixum (the refuse from aquafortis), put all into an earthenware pipkin with 5 oz. water, *warm* over the fire, add 1 oz. gilders' wax, and gently simmer for a short time. To be used when nearly cold.

(6) This amplifies (2). Jewellery to be coloured should be at least 15 carats fine, and the solder should be only a shade under that. There must be no pewter or silver solder on it. It should just be annealed, and pickled in water

to which sufficient sulphuric acid has been added to render it sharply acid to the taste. The best vessel to use for colouring is an ordinary clay crucible; the colouring mixture is composed of 2 oz. best saltpetre, 1 oz. alum, and 1 oz. common salt. These are placed in the crucible with sufficient water to moisten them, and when they are melted place the gold articles in the mixture. The jewellery must be strung on a piece of wire. It is better to keep a piece of platinum for this purpose, which should be annealed each time before use; failing that, a piece of gold wire (15 carat). You may use silver wire, but nothing baser. The colouring composition dissolves the silver, so you will require a fresh piece occasionally. You must move them about at intervals in the crucible, and as the composition gets thick add a very little hot water from time to time. It must not be made too thin, but just sufficiently liquid to boil. The goods require to be in almost continual motion, or they will stick to the bottom of the crucible. Should this untoward (and in the hands of a novice far from unlikely) event happen, don't attempt to pull them out by force, but boil them out with hot water. After they have been in the crucible for a few minutes, take them out and examine them; but whenever they are taken out they must be plunged at once into boiling water, or the composition will dry on them, and you will have some difficulty in removing it. They should now be scratch-brushed and returned to the crucible. From 10 to 20 minutes will be sufficient. When they are coloured, take them out, scratch-brush, wash in clean hot water, and dry in boxwood sawdust. This process acts by dissolving away the alloy, and leaving only the pure gold on the surface. If the goods are anything less than 15-carat gold, they must be electro-gilt.

Gun-metal. — For "blacking" gun-barrels, 2 oz. solution of nitric acid, 4 oz. tincture of steel, 3 oz. spirits of wine, 3 oz. sweet spirits of nitre, 1 oz. vitriol blue, 1½ pint rain-water. Scour the barrel smooth; remove all grease with lime, then coat with the mixture freely with a piece of sponge, but not so as to run about the barrel. Let stand in a cool place for about 10 hours; then remove to a warm room, and let stand till dry, when the rust will fly off, and not be sticky or streaky. The barrels are not dry, and must stand until quite dry, or the result will be a red barrel. The scratching must be done with lard, then boil for about 10 minutes; take out and wipe inside and out; let stand till cool, then scratch to remove the dead rust; wipe with clean rag, then coat with the mixture lightly; let stand till dry. Scratch, boil, &c., as in first coat for 6 coats, when the barrels may be finished by oiling. If this process be carried out, the barrels will be as black as soot. The furniture should be polished as bright as possible, and blued in the second blue, which will be what gunsmiths call "blacking."

Browning Gunbarrels.—Wet a piece of rag with antimony chloride, dip it into olive-oil, and rub the barrel over. In 48 hours it will be covered with a fine coat of rust. Remove this with a scratch-brush, and apply oil.

Iron and Steel.—Dissolve in 4 parts water, 2 of crystallized iron chloride, 2 of antimony chloride, and 1 of gallic acid, and apply the solution with a sponge or cloth to the article, and dry it in the air. Repeat this any number of times, according to the depth of colour which it is desired to produce. Wash with water, and dry, and finally rub the articles over with boiled linseed-oil. The metal thus receives a brown tint, and resists moisture. The antimony chloride should be as little acid as possible.

Silver.—(1) Silver which has become much tarnished may be restored by immersion in a warm solution of 1 part cyanide of potassium to 8 of water. (This mixture is extremely poisonous.) Washing well with water, and drying, will produce a somewhat dead-white appearance, which may be quickly changed to a brilliant lustre by polishing with a soft leather and rouge.

(2) Have ready a basin containing equal parts vitriol and water, make the article white in a gas flame (not white heat, but a snowy white, which it will assume after exposure to the flame), then plunge it into the pickle, and there leave it for ½ hour, then dry in box dust.

(3) Heat to a dull red (if there is no lead present), allow to cool, and when cold boil in a pickle of water acidulated with sulphuric acid (30 water, 1 acid) until perfectly white; take out, swill in clean water, and burnish the prominent parts; dry in hot boxwood sawdust.

(4) A simple way—but not half so good—is to brush up with whiting moistened with turpentine, and then wash out in clean hot water and dry in the sawdust.

Zinc.—Puscher employs acetate of lead for this purpose. On applying this substance, mixed with a minium preparation, a reddish-brown tinge is obtained. The cupola of the synagogue at Nuremburg was thus coloured, as an experiment, over a year ago, and to all appearance is yet unaffected by the weather. By adding other bases, lighter or darker tints of grey and yellow may be obtained, giving the zinc-work the appearance of carved stone. With a solution of chlorate of copper, the preparation turns the sheets of zinc black. (*Iron.*)

Paper.—The following recipes for coloured papers are mainly derived from Dunbar.

Amber.—(1) For 400 lb. dry paper. 400 lb. Oran esparto, ½ lb. chrome yellow, mixed in the engine one hour; 1 pint iron liquor, 20 lb. alum, 6 pails size.

(2) Fine Amber Writings.—For 300 lb. dry paper. *Medium Spanish esparto*, ½; F. F. rags, ¼; thirds, ¼; 6½ oz. nitrate of lead, 3 oz. bichromate of potash, 11 oz. Venetian red strained through a silk bag, 30 lb. alum, 8 pails size.

Blue.—(1) Aniline Blue.—For 250 lb. dry paper. No. 4 stuff, full bleached; 5 pails size, 15 lb. alum, 3 oz. aniline blue, ⅙ oz. diamond fuchsine.

(2) Aniline Blue, deep shade.—For 250 lb. dry paper. No. 4 stuff, full bleached; 5 pails size, 20 lb. alum, 4 oz. aniline blue, ⅙ oz. diamond fuchsine.

(3) Deep Aniline Blue.—For 250 lb. dry paper.—No. 3 stuff, full bleached; 6 pails size, 20 lb. alum, 4½ oz. aniline blue, ⅙ oz. diamond fuchsine.

(4) Aniline Blue, deep colour.—For 250 lb. dry paper. No. 4 stuff, full bleached; 4 pails size, 15 lb. alum, 2 oz. aniline blue, ⅙ oz. diamond fuchsine, 6 oz. Berlin blue.

(5) Deep Aniline Blue.—For 250 lb. dry paper. No. 4 stuff, full bleached; 5 pails size, 20 lb. alum, 9 lb. Paris blue, 3½ oz. aniline blue, 3 oz. diamond fuchsine. Presents a fine clear colour, very deep and uniform.

(6) Berlin Blue.—For 250 lb. dry paper. No. 4 stuff, half bleached; 5 pails size, 20 lb. alum, ½ oz. fuchsine, 5 lb. Paris blue.

(7) Blue Tissue.—For 200 lb. dry paper. Rope stuff, ½, good sailcloth, ½; 2 lb. ultramarine, B.B.A.C., 5 gills Brazil-wood dye.

(8) Fine Deep Blue.—For 400 lb. dry paper. Oran esparto; 1 lb. crystal soda, 10 lb. prussiate of potash, 3 lb. green copperas dissolved in 4 pails hot water, 4 qt. iron liquor, 1 oz. magenta dissolved in one pail of hot water, 25 lb. alum.

(9) Deep Paris Blue.—For 250 lb. dry paper. No. 4 stuff, half bleached; 4 pails size, 20 lb. alum, 2 lb. logwood extract, 6 lb. Berlin or Paris blue, 2 pints cochineal.

Brown.—(1) Soluble Brown.—For 250 lb. dry paper. No. 4 stuff, half bleached; 5 pails size, 20 lb. alum, 15 lb. soluble brown. *This colouring matter must be carefully strained into the engine. It is the best substitute for catechu-dyed papers, and has all the characteristics of catechu, with the advantage of being much cheaper.*

(2) Catechu Brown.—For 250 lb. dry paper. No. 4 stuff, unbleached; 4 pails size, 20 lb. alum, 12 pails catechu, 6 lb. bichromate, 3 lb. crystal soda.

(3) Catechu Brown.—For 250 lb. dry paper. No. 4 stuff, full bleached; 4½ lb.

green copperas, 4 pails size, 3 pails catechu, 20 lb. alum, 3½ lb. bichromate.

(4) Catechu Brown, deep colour.—For 150 lb. dry paper. No. 4 stuff, unbleached; 3 pails size, 10 lb. alum, 3 pails catechu, 2 lb. green copperas, 3 lb. bichromate.

(5) Catechu Brown.—For 250 lb. dry paper. No. 4 stuff, half bleached; 4 pails size, 4 pails catechu, 20 lb. alum, 1½ lb. bichromate.

(6) Catechu Brown Wrapping.—For 250 lb. dry paper. Hemp bagging, ½; No. 4 stuff, ½; 7 pails catechu, 5 pails size, 15 lb. alum, 3 lb. bichromate.

Buff.—(1) For 250 lb. dry paper. No. 4 stuff; 60 lb. yellow wood, 4 pails size, 20 lb. alum, 13 lb. yellow ochre, 10 oz. Venetian red, 1 gill Brazil-wood dye.

(2) Light Buff.—For 400 lb. dry paper. 400 lb. Oran esparto, 4 lb. green copperas, 4 oz. sugar of lead, 3 lb. bichromate of potash, 15 lb. alum, 5 pails size.

Chocolate.—For 400 lb. dry paper. 400 lb. Oran esparto, 37 lb. Venetian red, 3 lb. catechu, 5 lb. bluestone, 5 lb. green copperas, 4 lb. ultramarine—all 1 hour apart; 20 lb. alum, 7 pails size.

Crowfoot Colour to Paper Pulp.—The colour of the crowfoot is one of the most agreeable in paper manufacture, but it is also very difficult to obtain in all the richness and brilliancy of the flower's hue. As in the case of many other colours for paper, the operation requires to be divided into two parts. With every 220 lb. of dry pulp the following process is observed:—On the one hand, 26½ lb. acetate of lead are boiled separately in about 8 gal. water, and 8¾ lb. bichromate of potash in 4½ gal. water on the other. When the salts are completely dissolved, the same quantity of cold water is added to each solution as was used before; it is stirred, and the solution of acetate of lead is poured into that of the bichromate, the whole being stirred as the mixing takes place. The mixture is used in two separate basins, or troughs, and produces the first colouring of the pulp. Supposing, as is to be expected, a uniform tint has been obtained, about 3½ pints of a yellow-orange colour are added, which are prepared in the following manner: 5½ gal. caustic soda lye, marking 20° B., are taken, to which are added 23 lb. acetate of lead, and 7½ lb. bichromate of potash, mixed dry, the whole being boiled for ½ hour. From this are taken the 3½ pints mentioned above for the second colouring. (*La Gaceta Industrial.*)

Fawn.—(1) For 250 lb. dry paper. No. 4 stuff; 4 pails size, 20 lb. alum, 2 lb. green copperas, 2 lb. crystal soda. 1½ lb. Venetian red.

(2) For 250 lb. dry paper. No. 4 stuff; 20 lb. chemical wood pulp, 5 oz. ultramarine, 1 lb. Venetian red, 4 lb. French yellow ochre.

Green.—(1) For 250 lb. dry paper. No. 4 stuff; 60 lb. mechanical wood pulp, 2½ lb. bichromate 15 minutes later, 6 lb. sugar of lead 15 minutes later, 7 oz. Paris blue, 4 pails size, 15 lb. alum.

(2) Medium Deep Shade.—For 250 lb. dry paper. No. 4 stuff; 60 lb. mechanical wood pulp, 5 pails size, 20 lb. alum, 2½ lb. bichromate 15 minutes later, 6 lb. sugar of lead 15 minutes later, 1½ lb. Paris blue.

(3) Deep Clear Tint.—For 250 lb. dry paper. No. 3 stuff; 1½ lb. bichromate, 3 lb. sugar of lead 15 minutes later, 2 lb. Paris blue 10 minutes later, 5 pails size, 20 lb. alum.

(4) Deep Green.—For 250 lb. dry paper. No. 3 stuff; 5 pails size, 20 lb. alum, 22 lb. silk green paste, extra fine. A beautiful clear green.

(5) Pale Green.—For 250 lb. dry paper. No. 4 stuff, full bleached; 60 lb. wood pulp, 3 oz. bichromate, 6 oz. sugar of lead, 4 pails size, 15 lb. alum, 3 lb. Paris blue.

(6) Pale Green.—For 250 lb. dry paper. No. 4 stuff, full bleached; 4 pails size, 20 lb. alum, ¾ lb. bichromate 10 minutes later, 2¼ lb. sugar of lead 10 minutes later, 15 oz. Paris blue dissolved in hot water, adding ½ gill sulphuric acid.

Grey.—(1) For 250 lb. dry paper. No. 4 stuff, half bleached; 4 pails size, 20 lb. alum, 3 lb. green copperas, 3 lb. crystal soda, 4 lb. dark yellow ochre, 4 lb. light yellow ochre, 5 oz. Venetian red.

(2) Fine Grey Writings.—For 250 lb. dry paper. No. 4 stuff, full bleached; 3 lb. ultramarine, B.B.R.V.; 2 lb. Venetian red, 4 lb. yellow ochre, 6 pails size, 20 lb. alum.

(3) Fine Grey Writings.—For 250 lb. dry paper. No. 4 stuff, full bleached; 6 pails size, 25 lb. alum, 15 oz. bichromate, 2½ lb. sugar of lead, 6 oz. Paris blue ½ hr. later, 7 oz. logwood extract.

(4) Fine Grey Writings.—For 250 lb. dry paper. No. 4 stuff, full bleached; 6 pails size, 25 lb. alum, 12 oz. bichromate, 2 lb. sugar of lead, to be dissolved together in one pail, and put into the engine while hot; 3 oz. Paris blue ½ hour later, 4 oz. logwood extract.

(5) Superfine Grey Writings.—For 250 lb. dry paper. No. 3 stuff, full bleached; 4 lb. ultramarine, B.B.A.C.; 1 lb. bichromate, 1½ lb. sugar of lead, 3 lb. Venetian red, 6 pails size, 25 lb. alum.

Lilac.—(1) For 250 lb. dry paper. No. 4 stuff, full bleached; 5 pails size, 20 lb. alum, 3 oz. aniline blue, ½ oz. diamond fuchsine.

(2) Deep Lilac. For 250 lb. dry paper. No. 3 stuff; 5 pails size, 20 lb. alum; 30 oz. methyl violet, marked B.B.B.; ½ oz. eosine, marked A.

(3) Deep Lilac.—For 250 lb. dry paper. Nos. 3 and 4 stuffs, half and half; 4 pails size, 15 lb. alum, 2 oz. aniline blue, 2 oz. diamond fuchsine, 3½ oz. Paris blue.

(4) Deep Lilac.—For 250 lb. dry paper. No. 4 stuff, full bleached; 5 pails size, 20 lb. alum, 4 oz. aniline blue, 1 oz. diamond fuchsine.

(5) Deep Lilac.—For 250 lb. dry paper. No. 4 stuff; 20 lb. alum, 4 pails size, 8 oz. diamond fuchsine, 3 oz. aniline blue, 50 lb. straw pulp.

(6) Lilac Tissue.—Deep Shade. For 200 lb. dry paper. Nos. 17 and 18 rope stuffs, ½; No. 5 stuff, ½; 8 oz. aniline blue, 3 oz. diamond fuchsine, 2 oz. methyl violet, R.R.R.R. brand.

Nankeen Tissue.—For 200 lb. dry paper. Nos. 17 and 18 rope stuffs, ½; canvas, ½; 3 lb. potash, 3 lb. green copperas, 2 lb. crystal soda.

Olive, Deep.—For 250 lb. dry paper. No. 4 stuff; 60 lb. wood pulp, 4 pails size, 15 lb. alum, 2 lb. green copperas, 2 lb. crystal soda, 2¼ lb. Venetian red.

Orange.—(1) For 250 lb. dry paper. No. 4 stuff, only half-bleached or gas-bleached, and not potched; 3 pails size, 15 lb. alum, 6 lb. bichromate, 8 lb. sugar of lead, 60 lb. superfine orange.

(2) For 250 lb. dry paper. No. 4 stuff; 50 lb. mechanical wood pulp, 12 lb. orange mineral, 15 lb. alum, 4 pails size.

(3) For 250 lb. dry paper. No. 4 stuff; 60 lb. mechanical wood pulp, 15 lb. alum, 4 pails size, 30 lb. orange mineral.

(4) For 250 lb. dry paper. No. 4 stuff; 60 lb. mechanical wood pulp, 15 lb. alum, 3 pails size, 15 lb. orange mineral, 1 lb. Venetian red.

(5) For 200 lb. dry paper. No. 4 stuff; 50 lb. yellow mechanical wood pulp, 20 lb. orange mineral, 1½ lb. Venetian red, 4 pails size, 20 lb. alum. The orange and the Venetian red must be carefully strained through a fine wire or flannel bag.

(6) Orange Buff.—For 400 lb. dry paper. 400 lb. Oran esparto, 6 lb. bichromate of potash, 8 lb. sugar of lead, 14 lb. Venetian red, 20 lb. alum, 6 pails size.

(7) Chrome Orange.—For 300 lb. dry paper. No. 1 stuff, full bleached; 25 lb. alum, 6 pails size, 56 lb. chrome orange paste, No. 1. A fine clear orange for a good quality of paper.

(8) Deep orange.—For 250 lb. dry paper. No. 4 stuff; 40 lb. wood pulp, 4 pails size, 20 lb. alum, 6 lb. bichromate, 18 lb. sugar of lead, 25 lb. Venetian red, 50 lb. straw pulp.

(9) Pale Orange.—For 250 lb. dry paper. No. 4 stuff; 40 lb. wood pulp, 4 pails size, 15 lb. alum, 15 lb. superfine orange.

(10) Orange Yellow.—For 250 lb. dry paper. No. 4 stuff; 40 lb. mechanical wood pulp, 3 pails size, 15 lb. alum, 6 lb. bichromate, 8 lb. sugar of

lead, 25 lb. Venetian red, 50 lb. straw pulp.

(11) Orange Yellow.—For 400 lb. dry paper. Oran esparto; 7½ lb. bichromate, 15 lb. brown sugar of lead, dissolved in 5 pails hot water—strain through a flannel bag; ¼ lb. Venetian red, 25 lb. alum, 7 pails size.

Pink.—(1) For 250 lb. dry paper. No. 4 stuff; 5 pails size, 20 lb. alum, 3 oz. diamond fuchsine, dissolved in 300 oz. boiling water and strained through a fine flannel or silk bag.

(2) Eosine, A. — For 250 lb. dry paper. No. 3 stuff, full bleached; 13 oz. eosine, marked A; ½ oz. methyl violet. A deep pink of a beautiful shade.

(3) Deep Eosine Pink.—For 250 lb. dry paper. No. 3 stuff; 5 pails size, 20 lb. alum, 12 oz. eosine, marked B.N., dissolved in boiling water, and strained through a flannel bag into the engine.

(4) Pale Pink Eosine.—For 250 lb. dry paper. No. 3 stuff; 5 pails size, 20 lb. alum, 3 oz. eosine, marked B.N., ½ oz. methyl violet; strain into the engine.

Red.—(1) Deep Venetian.—For 200 lb. dry paper. No. 4 stuff, unbleached; 5 pails size, 20 lb. alum, 2½ lb. yellow ochre, 50 lb. Venetian red, 3 pints Brazil-wood dye.

(2) Venetian Red.—For 250 lb. dry paper. No. 3 stuff, unbleached; 50 lb. chemical wood pulp, 4 pails size, 15 lb. alum, 60 lb. Venetian red, 3 pints Brazil-wood dye.

(3) Venetian Red.—For 250 lb. dry paper. No. 4 stuff, half-bleached; 2½ lb. yellow ochre, 45 lb. Venetian red, 20 lb. alum, 5 pails size.

(4) Venetian Red.—For 250 lb. dry paper. No. 4 stuff; 40 lb. yellow wood pulp, 4 pails size, 15 lb. alum, 48 lb. yellow ochre, 50 lb. Venetian red. A beautiful deep Venetian red, principally used for the covers of serials.

(5) Saturnine Red.—For 250 lb. dry paper. No. 3 stuff; 4 pails size, 20 lb. alum, 50 lb. saturnine red, 5 lb. superfine orange.

Rose.—(1) For 400 lb. dry paper. 400 lb. Oran esparto, 14 lb. Venetian red, 1 lb. chrome yellow, 20 lb. alum.

(2) Fine Rose Tint.—For 400 lb. dry paper. Medium Spanish esparto, ½; good Oran esparto, ½; 2 oz. eosine, marked A, dissolved in one pail of boiling water and strained through a flannel bag.

Skin Colour.—For 250 lb. dry paper. No. 4 stuff, 60 lb. wood pulp, 4 pails size, 20 lb. alum, 9¼ lb. green copperas, 10½ lb. crystal soda, 8 oz. bichromate, 1½ lb. sugar of lead.

Straw Tint.—For 400 lb. dry paper. 400 lb. Oran esparto, 1½ lb. bichromate of potash, 3 lb. white sugar of lead dissolved in one pail of hot water, ¼ lb. ultramarine, 1½ pint iron liquor.

Violet.—Deep Shade.—For 250 lb. dry paper. No. 3 stuff, full bleached; 25 lb. alum, 5 pails size, 6 lb. methyl violet, marked R.R.R.R., 3 oz. methyl blue.

White Tissue.—For 200 lb. dry paper. Nos. 17 and 18 rope stuffs, ½; No. 5 stuff, ½; 5 oz. ultramarine, B.B.A.C.; 2 gills Brazil-wood dye.

Yellow.—(1) For 250 lb. dry paper. No. 4 stuff; 4 lb. bichromate 20 minutes later, 8 lb. sugar of lead ½ hour later, 20 lb. alum, 6 pails size, 40 lb. straw pulp.

(2) For 250 lb. dry paper. No. 4 stuff; 15 lb. alum, 4 pails size, 1¼ lb. bichromate, 5 lb. sugar of lead.

(3) For 250 lb. dry paper. No. 4 stuff; 40 lb. mechanical wood pulp, 15 lb. alum, 4 pails size, 5 lb. bichromate, 8 lb. sugar of lead.

(4) For 250 lb. dry paper. No. 4 stuff; 20 lb. mechanical wood pulp, 2¼ lb. bichromate 20 minutes later, 7½ lb. sugar of lead ½ hour later, 20 lb. alum, 4 pails size.

(5) For 250 lb. dry paper. No. 4 stuff; 40 lb. mechanical wood pulp, 15 lb. alum, 4 pails size, 5 lb. bichromate, 11 lb. sugar of lead.

(6) Dark Yellow.—For 400 lb. dry paper. 14 lb. bichromate of potash, 1¾ lb. brown sugar of lead dissolved in one pail of hot water—strain into the engine through a flannel bag; 2½ lb. green copperas 1 hour later, 25 lb. alum.

(7) Yellow Ochre, for Wrapping.—For 250 lb. dry paper. No. 4 stuff, unbleached; 60 lb. wood pulp, No. 2

quality; 4 pails size, 15 lb. alum, 20 lb. yellow ochre, 5 oz. Venetian red, 4 oz. magenta lake.

(8) Yellow Printings.—For 250 lb. dry paper. No. 4 stuff, *half bleached*; 30 lb. mechanical wood pulp, 1¼ lb. bichromate 20 minutes later, ¾ lb. sugar of lead ½ hour later, 15 lb. alum, 3 pails size, 50 lb. straw pulp.

(9) For 450 lb. dry paper. Tunis esparto, ½; No. 2 Spanish esparto, ½; 20 lb. French ochre, 4 lb. dark English ochre, 8 lb. sugar of lead, 4½ lb. bichromate, 2 lb. red chrome.

(10) For 400 lb. dry paper. Tunis esparto, ½; Oran esparto, ½; 3½ lb. bichromate, 7 lb. sugar of lead.

(11) Fine Yellow Printings.—For 200 lb. dry paper. Spanish esparto, ½; Oran esparto, ½; 2 lb. bichromate, 4 lb. sugar of lead, 3 pails size, 10 lb. alum.

(12) Yellow Wrapping.—For 250 lb. dry paper. No. 4 stuff, unbleached; 50 lb. wood pulp, No. 2 quality; 4 pails size, 20 lb. alum, 16½ lb. brown sugar of lead, 8 lb. bichromate, 20 lb. Venetian red.

(13) Yellow Wrapping, for Post Paper.—For 250 lb. dry paper. No. 4 stuff; 60 lb. mechanical wood pulp, 2 lb. bichromate of potash 15 minutes later; 4 lb. sugar of lead, 20 lb. alum, 4 pails size, 50 lb. straw pulp by Lahosse's system.

Parchment.—(1) Prepare the parchment with "*pounce*" as for writing. Use ordinary water-colours mixed with alum-water. The alum makes the parchment take the paints readily. Go over the part to be painted quickly with the colour. It is best to have the parchment on a slanting surface, as then the water does not soak in so much. Parchment does not cockle unless wet through.

(2) Green. Boil 8 parts cream of tartar and 30 of crystallized verdigris in 500 water; when this solution is cold, pour into it 4 parts nitric acid. Moisten the parchment with a brush, and then apply the above liquid evenly over its surface. The necessary surface finish is given with white of eggs, or mucilage of gum-arabic.

Silk.—*Blue.*—(1) Aniline Blue dyed with Soap.—For 11 lb. silk add to a water 17¼ oz. sulphuric acid and 3½ oz. solution of white soap. Stir well up and dye at 158° F. (70° C.) with 1¾ oz. aniline blue, which is added in 4 successive portions. Wash, brighten with vitriol sours, and rinse.

Green.—(1) On Old Mixed Silks (2 lb.). Boil out 25 dr. sumach in water, strain the liquid, and steep the goods overnight in the clear hot liquid. Take out the next morning, squeeze, and dye in a fresh cold beck of methyl green. If a yellower shade is required, picric acid is added.

Magenta.—(1) On Old Mixed Silks (2 lb.). Prepare and dye as in green (1), using cold solution of magenta instead of green.

Maroon.—(1) Take the silk through a catechu beck, weight for weight, if a good yield is desired. If a smaller yield is wished, less catechu is taken. Dye at a boil, lift, wring, and pass into a chrome beck at 6¾° to 8¼° Tw., and 77° F. (25° C.) If the shade required is very dark, the heat may be raised a little more. Wash well, make up a beck of fustic, extract of indigo, and orchil; add a little alum to draw on the fustic, and acidulate slightly with sulphuric acid for the blue. Dye at a boil, adding more of any of the colours as the shade may require.

Pansy.—(1) On Old Mixed Silks (2 lb.). Prepare as green (1), and dye to shade with a solution of methyl violet.

Scarlet.—(1) Boil for ½ hour 11 lb. ground cochineal; filter, and set the clear liquor at 4° Tw. Add to the beck about 24 fl. oz. tin solution, and dye. It requires 24 hours to produce the scarlet. After dyeing, the silks are left wrapped up for 12 hours, rinsed slightly, brightened with citric acid, and dried. The solution of tin is made of 4 lb. muriatic acid, 2 lb. nitric acid, 5 lb. feathered tin, dissolved gradually in the course of a day.

(2) Prepare in stannate of soda at 4° Tw. in the cold; take through weak vitriol sours, and wash well. Give a second mordant of red liquor at 8¼°

Tw., thickened with calcined starch at the rate of 3½ oz. per 35 fl. oz. of the mordant. Dry without rinsing for at least 24 hours; then rinse and dye with decoction of cochineal. When the colour is as deep as is required, add nitrate of tin to the same beck. This process gives scarlets as fine as (1), and with less loss of colouring matter. The object of the addition of calcined starch is to give the silk more body. In many dyeworks scarlets or silks are grounded with annatto.

Violet.—(1) Aniline Violets. Acidulate the water very slightly with sulphuric acid, and enter the silks. Begin to dye in the cold, adding the colour in small successive portions. Raise the heat gradually up to a boil to level the shade. If the tone is too blue, let the beck cool, and take the silks through again. They are then brightened by one or several successive passages through vitriol sours, and it must be remembered that heat increases the blueness and lessens the redness.

Yellow.—(1) The silk must not be washed, and a red shade is first given with annatto in a soap beck, not too strong. It is then washed and rinsed in the cold with sulphuric acid. The yellow shade is then given with picric acid, and the silk is dried without washing. For a heavier shade the process is the same, but turmeric is used instead of picric acid. The solution of annatto is made by boiling together for ½ hour equal weights of potash and annatto.

Straw.—(1) *Black.*—In order to obtain a level colour, a solution of gluten is added to a lye of soda, which is allowed to stand for 24 hours, and filtered. The hats are then steeped for 12 hours in the clear liquid. The straw is thus freed from grease, and the mordants of nitrate, sulphate, or acetate of iron, as well as the decoction of logwood mixed with sumach or galls, is very evenly taken up by the fibre. A slight addition of bichromate of potash improves the tone of the dye, and the goods are finished with gum or gelatine. (*Baden Gewerbezeitung.*)

(2) *Aniline Green.*—Straw is placed in boiling water, then well washed with cold water and bleached in a bath containing 20 gr. bleaching powder to 7 or 9 gr. sulphuric acid. It is then thoroughly washed and mordanted with sumach, alum, and tartaric acid (not too dilute a liquor). Finally, it is dyed with aniline green and picric acid until the required shade is obtained, after digesting for some time. (*Musterzeitung*).

Whitewashing, Calcimining, or Distemper.—(1) This is most commonly applied to ceilings and walls. If the ceiling is new, nothing further is required than a coat of good Paris white (whiting of a superior kind), with just sufficient glue-size added to bind it, provided the finishing plaster was of good workmanship; but if inferior and very porous, it will require a preparation of strong size, soft-soap, and a handful of plaster of Paris. For old ceilings, all the previous whiting, &c., must be thoroughly washed off with an old whitewash brush and hot water, and allowed to dry before re-whitening. When this is done, if the ceiling is "hot"—*i.e.* porous, and soaks in the moisture very quickly—it must be prepared with a mixture of lime, one handful; whiting, the same; glue, ½ lb.; soft-soap, ¼ lb.; and if smoky or damp, about 2 oz. alum, to make a pail ¾ full. When this is dry, it is ready for the finish. Use the preparation thin. To prepare whitewash properly, the whiting should be soaked overnight in plenty of water, thoroughly stirred up to wash it, and allowed to settle till the morning, when all the water possible should be drained off. The size should likewise be melted the night before use, so as to be jellied by the morning. It works better when cold. About ½ lb. glue is required to 1 gal. water, which, with the water taken up by the whiting, will make it ready for use. Before using, the size and whiting should be broken up separately and strained through a fine sieve; then mixed and strained again. Before putting on the whiting, shut all doors and windows to exclude the draught, take a sweep right across the room, and continue till finished. If two are engaged at it, so much the better, as it requires to be done quickly; be careful to cover well, or you will not make a nice job. When finished, the doors and windows can be opened, as the sooner it dries after it is once on the more even and solid will it look. For whitening and colouring walls, great care is required in preparing them; all the old stuff is to be cleared off, well rubbed down with dry lump pumice, all holes well and evenly stopped with plaster of Paris, and a preparation of strong size, whiting, and alum, thickly laid on, of the colour you are going to finish, but a little darker in shade. When this is well dry, rub it well down to a good level and smooth face with lump pumice or coarse sandpaper. The finishing coat may be made in the same way for the ceilings; but if exposed to the liability of being touched or rubbed against, a little more or stronger size is to be used; and if in any way to damp, a little alum. To get any of the colours required, it is merely necessary to get the dry powders and rub up with the whiting, prior to mixing with size, adding by degrees till the required depth of tone is arrived at. For the different shades of drab or stone-colour, yellow ochre, umber, black, and red are used. For shades of blue, from the French grey to sky blue, ultramarine, &c. (*Painting for the Million.*)

(2) If glue is employed to give body, it is destroyed by the corrosive action of the lime, and in consequence the latter easily rubs off the walls when dry. This is the case also if the lime is employed, as is often absurdly recommended, simply slaked in water, and used without any fixing material. Lime-wash is prepared by placing some freshly-burned quicklime in a pail, and pouring on sufficient water to cover it; boiled oil (linseed) should then be immediately added, in the proportion of 1 pint to 1 gal. of the wash. For coarser work, any common refuse fat may be used instead of the boiled oil. The whole should then be thinned with water to the required consistency, and applied with a brush. Care should be taken not to leave the brush in the lime-wash for any length of time, as it destroys the bristles. In lime-washing, Russia tallow is frequently used in preference to any other fatty matters. (*Tegetmeier.*)

(3) No brick wall that ever is intended to be painted should be whitewashed. All washes absorb water, and in damp weather lose their colour. For one barrel of colour wash take $\frac{1}{2}$ bush. white lime, 3 pecks hydraulic cement, 10 lb. umber, 10 lb. ochre, 1 lb. Venetian red, $\frac{1}{4}$ lb. lampblack. Slake the lime, cut the lampblack with vinegar, mix well together, add the cement, and fill the barrel with water. Let it stand for 12 hours before using, and stir frequently while putting it on. This is not white, but of a light stone colour, without the unpleasant glare of white. The colour may be changed by adding more or less of the colours named, or other colours. This wash covers well, needing only one coat. A rough board barn washed with this will look well for 5 years, and even longer, without renewing. The cement hardens, but on a rough surface will not scale. (*Scient. Amer.*)

(4) A wash which can be applied to lime walls and afterwards become waterproof so as to bear washing. Resenschek, of Munich, mixes together the powder from 3 parts silicious rock (quartz), 3 parts broken marble and sandstone, 2 parts burned porcelain clay, with 2 parts freshly-slaked lime, still warm. In this way a wash is made which forms a silicate if often wetted, and becomes after a time almost like stone. The 4 constituents mixed together give the ground colour to which any pigment that can be used with lime is added. It is applied quite thickly to the wall or outer surface, let dry one day, and the next day frequently covered with water, which makes it waterproof. This wash can be cleansed with water without losing any of its colour; on the contrary, each time it gets harder, so that it can even

be brushed, while its porosity makes it look soft. The wash or calcimine can be used for ordinary purposes as well as for the finest painting. A so-called fresco surface can be prepared with it in the dry way.

(5) Well wash the ceiling by wetting it twice with water, laying on as much as can well be floated on, then rub the old colour up with a stumpy brush and wipe off with a large sponge. When this is done, stop all the cracks with whiting and plaster of Paris. When dry, claircole with size and a little of the whitewash. If very much stained when this is dry, paint those parts with turps, colour, and, if necessary, claircole again. To make the whitewash, take 12 lb. whiting (in large balls), break them up in a pail, and cover with water to soak. During this time melt over a slow fire 4 lb. common size, and at the same time, with a palette knife or small trowel, rub up fine about a dessert-spoonful of blue-black with water to a fine paste; then pour the water off the top of the whiting, and with a stick stir in the black; when well mixed, stir in the melted size and strain. When cold it is fit for use. If the jelly is too stiff for use, beat it well up and add a little cold water. Commence whitewashing over the window, and so work from the light; lay off the work into that done, and not all in one direction, as in painting. Distemper colour of any tint may be made by using any other colour instead of the blue-black — as ochre, chrome, Dutch pink, raw sienna for yellows and buff; Venetian red, burnt sienna, Indian red, or purple-brown for reds; celestial blue, ultramarine, indigo, for blues; red and blue for purple, grey, or lavender; red lead and chrome for orange; Brunswick green for greens. (*Smither.*)

(6) 1 doz. balls of whiting, 2 lb. size, and 1 oz. celestial or ultramarine blue; this will cover about 12 sq. yd. Mixing: Take the whiting and break up in just enough water that you can work it about in a bucket with a stout stick. Next take a saucepan, about 3 qt., and put a pint of water in and boil; take off the fire, and drop your size into it, and let it stand upon the hob until melted. When tolerably warm, pour into your whiting, being careful to keep stirring it. Mix up your blue with a flat stick upon a slate or board, and add until it becomes of the shade required. Lime that will produce a fast limewash is burnt in the bottom of brick kilns, the bricks upon the top, and fired with heath, fir loppings, coal, wood, ferns, and gorse. The sand from the bricks, the chalk, and the potash from the wood combined, cover the chalk or lime with a silicate soluble in water. To use this, get it fresh burnt, break it up, and pour boiling water upon it; it subsides into a beautiful cream-like consistence. This, owing to the soluble silicate in it, must be used and made fresh. It is fast, and frequently presents a glazed surface, and, if not put on too thick, is very durable. A peck of lime will do about 20 sq. yd.; this is merely lime — the fresher the better. Slake it. Make it of the proper consistence, and add to every bucket one gill of turps and linseed oil, mixed. Some use tallow, some size.

(7) Lime is always apt to turn a bad colour. The way to whitewash a ceiling is to first thoroughly wash with clean water—not one pail, which speedily gets dirty, but with several. Then steep balls of whiting in water, and the next day reduce them to a thick cream. Put a kettle on the fire, with sufficient size, and when hot pour it on the whiting, adding at the same time some finely-ground blue-black. The proportions are, say, 6 balls whiting, 2 lb. size, and ¼ to 1 oz. of blue-black, according to taste. The mixture must be allowed to cool before using. To limewash, clean first, and then proceed to make up the following: Take ½ bush. lime, and slake it; add 1 lb. common salt, ½ lb. white vitriol, and 1 gal. skim milk. With a clean surface, this will not shell off, neither will limewash and size, when properly prepared and laid on a clean surface.

(8) Recommended by the United

States Treasury Department to all the lighthouse keepers: it answers for wood, brick, or stone:—Slake about ½ bush. unslaked lime with boiling water, keeping it covered during the process. Strain it, and add 1 peck salt dissolved in warm water, 3 lb. ground rice put in boiling water and boiled to a thin paste, ½ lb. powdered Spanish whiting, and 1 lb. clear glue dissolved in warm water; mix these well together, and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace, and when used put it on as hot as possible with other painters' or whitewash brushes.

(9) Having prepared the ceilings, scraped them, washed them, or removed the blisters and inequalities, use any of the following, according to the kind of job operated on:—(*a*) Well-selected pieces of quicklime, free from the appearance of iron (avoid red streaked): slake with water; when all have fallen to powder, mix to proper consistency, and apply with a stock brush, about 6 in. broad; this is suitable for common purposes. (*b*) Common whiting, washed whiting, Paris whiting (or gilders' white), mixed with water and a little size (strong glue boiled down); these are suitable for all parts of a house, from the kitchen to the drawing-room. (*c*) For a superior job, and where there is much gas burnt, use white oxide of zinc in water, and a little size; this will keep beautifully white a very long time, but is dear. In some cases it is desirable to first paper the ceiling with cartridge-paper before whitewashing. Considerable practice is necessary to lay on the wash quite even. Be careful not to leave clouds or tails where the brush leaves the roof after the stroke, and above all see that the ceiling is not dusty. (*Kemp.*)

Wine.—Various matters are largely employed to artificially heighten the colours of wines. The following are among the number:—

(1) Malva flowers or hollyhock produce, when steeped in spirits for 24 hours, or even when boiled with water, a very beautiful purple.

(2) The pokeberry (the dark berries from the plant growing all over the United States) has a very dark red colour.

(3) Whortleberry, elderberry, blackberry, and mulberry.

(4) Brazil-wood, Sanders-wood, and logwood. These woods are boiled in water, and the decoctions yield shades of colour from red to blue.

(5) Cochineal gives a fine red colour by boiling finely-ground cochineal with cream of tartar.

(6) Orchil produces a beautiful purple.

(7) Red beets and carrots produce likewise a good colour.

(8) Indigo solution, neutralized by potash, produces a fine blue.

(9) Annatto and extract of safflower produce a beautiful yellow.

(10) Turmeric is the most common colour for yellow, as the spirit extracts all colour immediately; as also quercitron bark.

(11) Red cabbage produces a beautiful bluish-red.

(12) Garacine (extract of madder) produces various shades of red.

(13) Tincture of saffron (Spanish saffron) for yellow.

(14) Blue vitriol, or solution of indigo, produces blue.

(15) Burnt sugar produces a fine and permanent brown colour for wines. It is best to boil down common sugar or loaf-sugar nearly to dryness. It is then dissolved in hot water sufficient to make the consistency of syrup; and for the purpose of neutralizing it and making it a more permanent colour, add to each gallon of sugar-colour about 1 oz. liquid ammonia.

(16) Green colour for absinth is prepared from a solution of extract of indigo and turmeric, dissolved in spirits.

(17) Violet is obtained by a solution of extract of logwood and alum.

(18) Barwood acquires a dark wine-red colour by digesting in alcohol.

(19) Brazil-wood, by being macerated in alcohol, or by boiling for ½ hour, produces a deep red.

(20) Alkanet-root produces a fine blue-red by macerating in alcohol.

(21) Fuchsine, an aniline colour, is now largely employed as a substitute for ammoniacal extract of cochineal.

Wood.—The practice of staining woods is much less common in America and England than on the Continent, where workmen, familiar with the different washes, produce the most delicate tones of colour and shade. Wood is often stained to imitate darker and dearer varieties, but more legitimately to improve the natural appearance by heightening and bringing out the original markings, or by giving a definite colour without covering the surface and hiding the nature of the material by coats of paint. The best woods for staining are those of close even texture, as pear and cherry, birch, beech, and maple, though softer and coarser kinds may be treated with good effect. The wood should be dried, and if an even tint is desired, its surface planed and sand-papered. All the stains should, if possible, be applied hot, as they thus penetrate more deeply into the pores. If the wood is to be varnished, and not subjected to much handling, almost any of the brilliant mordants used in wool and cotton dyeing may be employed in an alcoholic solution; but when thus coloured it has an unnatural appearance, and is best used in small surfaces only, for inlaying, &c. The ebonised wood, of late years so much in vogue, is in many respects the most unsatisfactoy of the stains, as the natural character and markings are completely blotted out, and it shows the least scratch or rubbing. Sometimes, in consequence of the quality of the wood under treatment, it must be freed from its natural colours by a preliminary bleaching process. To this end it is saturated as completely as possible with a clear solution of 17½ oz. chloride of lime and 2 oz. soda crystals, in 10½ pints water. In this liquid the wood is steeped for ½ hour, if it does not appear to injure its texture. After this bleaching, it is immersed in a solution of sulphurous acid to remove all traces of chlorine, and then washed in pure water. The sulphurous acid, which may cling to the wood in spite of washing, does not appear to injure it, nor alter the colours which are applied.

Black.—(1) Obtained by boiling together blue Brazil-wood, powdered gall-apples, and alum, in rain or river water, until it becomes black. This liquid is then filtered through a fine organzine, and the objects painted with a new brush before the decoction has cooled, and this repeated until the wood appears of a fine black colour. It is then coated with the following liquid:—A mixture of iron filings, vitriol, and vinegar is heated (without boiling), and left a few days to settle. Even if the wood is black enough, yet for the sake of durability, it must be coated with a solution of alum and nitric acid, mixed with a little verdigris; then a decoction of gall-apples and logwood dyes is used to give it a deep black. A decoction may be made of brown Brazil-wood with alum in rain-water, without gall-apples; the wood is left standing in it for some days in a moderately warm place, and to it merely iron filings in strong vinegar are added, and both are boiled with the wood over a gentle fire. For this purpose soft pear-wood is chosen, which is preferable to all others for black staining.

(2) 1 oz. nut-gall broken into small pieces, put into barely ½ pint vinegar, which must be contained in an open vessel; let stand for about ½ hour; add 1 oz. steel filings; the vinegar will then commence effervescing; cover up, but not sufficient to exclude all air. The solution must then stand for about 2½ hours, when it will be ready for use. Apply the solution with a brush or piece of rag to the article, then let it remain until dry; if not black enough, coat it until it is—each time, of course, letting it remain sufficiently long to dry thoroughly. After the solution is made, keep it in a closely-corked bottle.

(3) 1 gal. water, 1 lb. logwood chips, ½ lb. black copperas, ½ lb. extract of logwood, ½ lb. indigo blue, 2 oz. lamp-black. Put these into an iron pot and boil them over a slow fire. When the mixture is cool, strain it through a cloth, add ¼ oz. nut-gall. It is then

ready for use. This is a good black for all kinds of cheap work.

(4) 250 parts Campeachy wood, 2000 water, and 30 sulphate of copper; the wood is allowed to stand 24 hours in this liquor, dried in the air, and finally immersed in nitrate of iron liquor at 4° B.

(5) Boil 8¾ oz. logwood in 70 oz. water and 1 oz. blue stone, and steep the wood for 24 hours. Take out, expose to the air for a long time, and then steep for 12 hours in a beck of nitrate of iron at 4° B. If the black is not fine, steep again in logwood liquor.

(6) It is customary to employ the clear liquid obtained by treating 2 parts powdered galls with 15 parts wine, and mixing the filtered liquid with a solution of iron protosulphate. Reimann recommends the use of water in the place of wine.

(7) Almost any wood can be dyed black by the following means:—Take logwood extract such as is found in commerce, powder 1 oz., and boil it in 3¼ pints water; when the extract is dissolved, add 1 dr. yellow chromate of potash (not the bichromate), and agitate the whole. The operation is now finished, and the liquid will serve equally well to write with or to stain wood. Its colour is a very fine dark purple, which becomes a pure black when applied to the wood.

(8) For black and gold furniture, procure 1 lb. logwood chips, add 2 qt. water, boil 1 hour, brush the liquor in hot, when dry give another coat. Now procure 1 oz. green copperas, dissolve it in warm water, well mix, and brush the solution over the wood: it will bring out a fine black; but the wood should be dried outdoors, as the black sets better. A common store brush is best. If polish cannot be used, proceed as follows:—Fill up the grain with black glue—*i.e.*, thin glue and lampblack—brushed over the parts accessible (not in the carvings); when dry, paper down with fine paper. Now procure, say, a gill of French polish, in which mix 1 oz. best ivory black, or gas black is best, well shake it until quite a thick pasty mass. procure ½ pint brown hard varnish, pour a portion into a cup, add enough black polish to make it quite dark, then varnish the work; two thin coats are better than one thick coat. The first coat may be glass-papered down where accessible, as it will look better. A coat of glaze over the whole gives a London finish. N.B.—Enough varnish should be mixed at once for the job to make it all one colour—*i.e.*, good black. (*Smither.*)

(9) For table.—Wash the surface of table with liquid ammonia, applied with a piece of rag; the varnish will then peel off like a skin; afterwards smooth down with fine sand-paper. Mix ¼ lb. lampblack with 1 qt. hot water, adding a little glue size; rub this stain well in; let it dry before sand-papering it; smooth again. Mind you don't work through the stain. Afterwards apply the following black varnish with a broad fine camel-hair brush:—Mix a small quantity of gas-black with the varnish. If one coat of varnish is not sufficient, apply a second one after the first is dry. Gas-black can be obtained by boiling a pot over the gas, letting the pot nearly touch the burner, when a fine jet black will form on the bottom, which remove, and mix with the varnish.

(10) Black-board wash, or "liquid slating."—(*a*) 4 pints 95 per cent. alcohol, 8 oz. shellac, 12 dr. lampblack, 20 dr. ultramarine blue, 4 oz. powdered rottenstone, 6 oz. powdered pumice. (*b*) 1 gal. 95 per cent. alcohol, 1 lb. shellac, 8 oz. best ivory black, 5 oz. finest flour emery, 4 oz. ultramarine blue. Make a perfect solution of the shellac in the alcohol before adding the other articles. To apply the slating, have the surface smooth and perfectly free from grease; well shake the bottle containing the preparation, and pour out a small quantity only into a dish, and apply it with a new flat varnish brush as rapidly as possible. Keep the bottle well corked, and shake it up each time before pouring out the liquid. (*c*) Lampblack and flour of emery mixed with spirit varnish. No more

lampblack and flour of emery should be used than are sufficient to give the required black abrading surface. The thinner the mixture the better. Lampblack should first be ground with a small quantity of spirit varnish or alcohol to free it from lumps. The composition should be applied to the smoothly-planed surface of a board with a common paint-brush. Let it become thoroughly dry and hard before it is used. Rub it down with pumice if too rough. (*d*) ½ gal. shellac varnish, 5 oz. lampblack, 3 oz. powdered iron ore or emery; if too thick, thin with alcohol. Give 3 coats of the composition, allowing each to dry before putting on the next; the first may be of shellac and lampblack alone.

(11) 17·5 oz. Brazil-wood and 0·525 oz. alum are boiled for 1 hour in 2·75 lb. water. The coloured liquor is then filtered from the boiled Brazil-wood, and applied several times boiling hot to the wood to be stained. This will assume a violet colour. This violet colour can be easily changed into black by preparing a solution of 2·1 oz. iron filings, and 1·05 oz. common salt in 17·5 oz. vinegar. The solution is filtered, and applied to the wood, which will then acquire a beautiful black colour.

(12) 8·75 oz. gall-nuts and 2·2 lb. logwood are boiled in 2·2 lb. rain-water for 1 hour in a copper boiler. The decoction is then filtered through a cloth, and applied several times while it is still warm to the article of wood to be stained. In this manner a beautiful black will be obtained.

(13) This is prepared by dissolving 0·525 oz. extract of logwood in 2·2 lb. hot rain-water, and by adding to the logwood solution 0·035 oz. chromate of potash. When this is applied several times to the article to be stained, a dark brown colour will first be obtained. To change this into a deep chrome-black, the solution of iron filings, common salt, and vinegar, given under (11) is applied to the wood, and the desired colour will be produced.

(14) Several coats of alizarine ink are applied to the wood, but every coat must be thoroughly dry before the other is put on. When the articles are dry, the solution of iron filings, common salt, and vinegar, as given in (11), is applied to the wood, and a very durable black will be obtained.

(15) According to Herzog, a black stain for wood, giving to it a colour resembling ebony, is obtained by treating the wood with two fluids, one after the other. The first fluid to be used consists of a very concentrated solution of logwood, and to 0·35 oz. of this fluid are added 0·017 oz. alum. The other fluid is obtained by digesting iron filings in vinegar. After the wood has been dipped in the first hot fluid, it is allowed to dry, and is then treated with the second fluid, several times if necessary.

Blue.—(1) Powder a little Prussian blue, and mix to the consistency of paint with bur; brush it on the wood, and when dry size it with glue dissolved in boiling water; apply lukewarm, and let this dry also; then varnish or French polish.

(2) Indigo solution, or a concentrated hot solution of blue vitriol, followed by a dip in a solution of washing soda.

(3) Prepare as for violet, and dye with aniline blue.

(4) A beautiful blue stain is obtained by gradually stirring 0·52 oz. finely-powdered indigo into 4·2 oz. sulphuric acid of 60 per cent., and by exposing this mixture for 12 hours to a temperature of 77° F. (25° C.). The mass is then poured into 11 to 13·2 lb. rain-water, and filtered through felt. This filtered water is applied several times to the wood, until the desired colour has been obtained. The more the solution is diluted with water, the lighter will be the colour.

(5) 1·05 oz. finest indigo carmine, dissolved in 8·75 oz. water, applied several times to the article to be stained. A very fine blue is in this manner obtained.

(6) 3·5 oz. French verdigris are dissolved in 3·5 oz. urine and 8·75 oz. wine vinegar. The solution is filtered and

applied to the article to be stained. Then a solution of 2·4 oz. carbonate of potash in 8·75 oz. rain-water is prepared, and the article coloured with the verdigris is brushed over with this solution until the desired blue colour makes its appearance.

(7) The newest processes of staining wood blue are those with aniline colours. The following colours may be chosen for the staining liquor:—Bleu de Lyon (reddish blue), bleu de lumière (pure blue), light blue (greenish blue). These colours are dissolved in the proportion of 1 part colouring substance to 30 of spirit of wine, and the wood is treated with the solution.

Brown.—(1) Various tones may be produced by mordanting with chromate of potash, and applying a decoction of fustic, of logwood, or of peachwood.

(2) Sulphuric acid, more or less diluted according to the intensity of the colour to be produced, is applied with a brush to the wood, previously cleaned and dried. A lighter or darker brown stain is obtained, according to the strength of the acid. When the acid has acted sufficiently, its further action is arrested by the application of ammonia.

(3) Tincture of iodine yields a fine brown coloration, which, however, is not permanent unless the air is excluded by a thick coating of polish.

(4) A simple brown wash is ½ oz. alkanet root, 1 oz. aloes, 1 oz. dragons'-blood, digested in 1 lb. alcohol. This is applied after the wood has been washed with aqua regia, but is, like all the alcoholic washes, not very durable.

Ebonising.—(1) Boil 1 lb. logwood chips 1 hour in 2 qt. water; brush the hot liquor over the work to be stained, lay aside to dry; when dry give another coat, still using it hot. When the second coat is dry, brush the following liquor over the work:—1 oz. green copperas to 1 qt. hot water, to be used when the copperas is all dissolved. It will bring out an intense black when dry. For staining, the work must not be dried by fire, but in the sunshine, if possible; if not, in a warm room, away from the fire. To polish this work first give a coating of very thin glue size, and when quite dry paper off very lightly with No. 0 paper, only just enough to render smooth, but not to remove the black stain. Then make a rubber of wadding about the size of a walnut, moisten the rubber with French polish, cover the whole tightly with a double linen rag, put one drop of oil on the surface, and rub the work with a circular motion. Should the rubber stick it requires more polish. Previous to putting the French polish on the wadding pledget, it ought to be mixed with the best drop black, in the proportion of ¼ oz. drop black to a gill of French polish. When the work has received one coat, set it aside to dry for about an hour. After the first coat is laid on and thoroughly dry, it should be partly papered off with No. 0 paper. This brings the surface even, and at the same time fills up the grain. Now give a second coat as before. Allow 24 hours to elapse, again paper off, and give a final coat as before. Now comes "spiriting off." Great care must be used here, or the work will be dull instead of bright. A clean rubber must be made, as previously described, but instead of being moistened with polish it must be wetted with spirits of wine placed in a linen rag screwed into a tight even-surfaced ball, just touched on the face with a drop of oil, and then rubbed lightly and quickly in circular sweeps all over the work from top to bottom. One application of spirits is usually enough if sufficient has been placed on the rubber at the outset, but it is better to use rather too little than too much at a time, as an excess will entirely remove the polish, when the work will have to be polished again. Should this be the case, paper off at once, and commence as at first. It is the best way in the end. (*Smither*).

(2) Lauber dissolves extract of logwood in boiling water until the solution indicates 0° Baumé. 5 pints of the solution is then mixed with 2½ pints pyroligneous iron mordant of 10°, and ½ pint acetic acid of 2°. The mixture

is heated for ¼ hour, and is then ready for use.

(3) To imitate black ebony, first wet the wood with a solution of logwood and copperas, boiled together and laid on hot. For this purpose, 2 oz. logwood chips with 1½ oz. copperas, to 1 qt. water, will be required. When the work has become dry, wet the surface again with a mixture of vinegar and steel filings. This mixture may be made by dissolving 2 oz. steel filings in ½ pint vinegar. When the work has become dry again, sandpaper down until quite smooth. Then oil and fill in with powdered drop-black mixed in the filler. Work to be ebonised should be smooth and free from holes, &c. The work may receive a light coat of quick-drying varnish, and then be rubbed with finely-pulverized pumice and linseed oil until very smooth.

(4) 1 gal. strong vinegar, 2 lb. extract of logwood, ½ lb. green copperas, ¼ lb. China blue, and 2 oz. nut-gall. Put these in an iron pot, and boil them over a slow fire till they are well dissolved. When cool, the mixture is ready for use. Add to the above ½ pint iron rust, which may be obtained by scraping rusty hoops, or preferably by steeping iron filings in a solution of acetic acid or strong vinegar.

(5) Common ebony stain is obtained by preparing two baths; the first, applied warm, consists of a logwood decoction, to every quart of which 1 dr. alum is added; the second is a solution of iron-filings in vinegar. After the wood has dried from the first, the second is applied as often as is required. For the first-named bath, some substitute 16 oz. gall-nut, 4 oz. logwood dust, and 2 oz. verdigris, boiled in a sufficient quantity of water. A peculiar method of blackening walnut is in use in Nurnberg. On one of the Pegnitz Islands there is a large grinding-mill, turned by the stream, where iron tools are sharpened and polished. The wood is buried for a week or more in the slime formed by the wheels; when dug out it is jet black, and so permeated by silica as to be in effect petrified Another way to ebonise flat surfaces o soft wood is to rub very fine charcoal-dust into the pores with oil. This works beautifully with the European linden and American whitewood. A brown mahogany-like stain is best used on elm and walnut. Take a pint decoction of 2 oz. logwood in which ½ oz. chloride of barium has been dissolved. This gives also, when diluted with soft water, a good oak stain to ash and chestnut. But the most beautiful and lasting of the browns is a concentrated solution of permanganate of potash (mineral chameleon). This is decomposed by the woody fibre, and forms hydrated oxide f manganese, which is permanently fixed by the alkali.

(6) For the fine black ebony stain, apple, pear, and hazel wood are the best woods to use; when stained black, they are most complete imitations of the natural ebony. For the stain take—gall-apple, 14 oz.; rasped logwood, 3½ oz.; vitriol, 1¾ oz.; verdigris, 1¾ oz. For the second coating a mixture of iron filings (pure), 3½ oz., dissolved in strong wine vinegar; 1½ pint is warmed, and when cool the wood already blackened is coated 2 or 3 times with it, allowing it to dry after each coat. For articles hich are to be thoroughly saturated, a mixture of 1¾ oz. sal-ammoniac, with a sufficient quantity of steel filings, is to be placed in a suitable vessel, strong vinegar poured upon it, and left for 14 days in a gently-heated oven. A strong lye is now put into a suitable pot, to which is added coarsely-bruised gall-apples and blue Brazil shavings, and exposed for the same time as the former to the gentle heat of an oven, which will then yield a good liquid. The woods are now laid in the first-named stain, boiled for a few hours, and left in it for 3 days longer; they are then placed in the second stain and treated as in the first. If the articles are not then thoroughly saturated, they may be once more placed in the first bath, and then in the second. The polish used for wood that is stained black should be "white" (colourless) polish, to which a very little finely-ground Prussian blue should be added.

(7) Wash with a concentrated aqueous solution of extract of logwood several times; then with a solution of acetate of iron of 14° B., which is repeated until a deep black is produced.

(8) Beech, pear-tree, or holly steeped in a strong liquor of logwood or galls. Let the wood dry, and wash over with solution of sulphate of iron. Wash with clean water, and repeat if colour is not dark enough. Polish either with black or common French polish.

(9) Oak is immersed for 48 hours in a hot saturated solution of alum, and then brushed over several times with a logwood decoction prepared as follows:—Boil 1 part best logwood with 10 of water, filter through linen, and evaporate at a gentle heat until the volume is reduced one-half. To every quart of this add 10 to 15 drops of a saturated solution of indigo, completely neutral. After applying this dye to the wood, rub the latter with a saturated and filtered solution of verdigris in hot concentrated acetic acid, and repeat the operation until a black of the desired intensity is obtained. Oak thus stained is said to be a close as well as handsome imitation of ebony.

(10) 1 lb. logwood chips, 3 pints water; boil to 1 pint; apply hot to wood; let dry; then give another coat; let dry slowly; sandpaper smooth; mix 1 gill vinegar with 3 tablespoonfuls iron or steel filings; let stand 5 hours, then brush on wood; let dry; then give another coat of the first. This sends the vinegar deeper into the wood and makes a denser black; after which paper smooth. Then polish with white French polish, as the white brings out the black purer than common French polish. The woods observed to take on the stain best are pear-tree, plane-tree, and straight-reeded birch; mahogany does not stain nearly so well as the former woods.

(11) Get 1 lb. of logwood chips and boil them down in enough water to make a good dark colour; give the furniture 3 or 4 coats with a sponge; then put some rusty nails or old iron into a bottle with some vinegar, and when it begins to work give the furniture a coat of the vinegar. This, if you have well darkened it with the first, will give you a good black. Oil and polish in the usual way, rubbing down first with fine paper if required. A quicker way is to give the wood a coat of size and lampblack, and then use gas-black in your polish rubber.

(12) Make a strong decoction of logwood by boiling 1 lb. in 1 qt. water for about 1 hour; add thereto a piece of washing soda as large as a hazel-nut. Apply hot to the wood with a soft brush. Allow to dry, then paint over the wood with a solution of sulphate of iron (1 oz. to the pint of water). Allow this to dry, and repeat the logwood and sulphate of iron for at least 3 times, finishing off with logwood. Once more allow to dry thoroughly, then sandpaper off very lightly (so as not to remove the dye) with No. 0 paper. Now make a very thin glue size, boil in it a few chips of logwood and a crystal or two of sulphate of iron, just sufficient to make it inky black. Paint this lightly over the work, allow to dry once more, again sandpaper lightly, and finally either varnish with good hard white varnish, or polish with French polish and drop black.

Floors.—(1) Get the wood clean, have some Vandyke brown and burnt sienna ground in water, mix it in strong size, put on with a whitewash or new paint brush as evenly as you can. When dry, give two coats of copal or oak varnish.

(2) If the floor is a new one, have the border well washed. Polish with glass-paper, rubbing always with the grain of the wood. Varnish with good oak varnish, put colouring matter into the varnish to suit your taste, but umber is best; if the floor is old and blackened, paint it.

(3) If old floors, you will not make much of staining anything but black. The floor is to be well washed (lime and soda is best—no soap), the dye painted on, and, when dry, sized over and varnished with elastic oak varnish.

(4) Take ½ lb. logwood chips, boil them briskly for ½ hour in about 5 qt. rain-water, and strain through muslin.

To this liquor add 6 oz. of annatto (in the form of cake—not the roll); add also 1 lb. of yellow wax cut up in very small pieces. Place these over the fire, and let the wax melt gently, stirring it all the while. When melted, take the mixture off the fire; do not let it boil. Then with a paint-brush lay it on the floor as hot as possible, brushing it always the way of the grain. Next day polish with a hard flat brush made of hair, which may have a strap nailed to the back of it in which to insert the foot. The floor is afterwards kept bright with beeswax alone, a little of which is melted and put on the brush. Take care that the floor is thoroughly dry before commencing operations.

(5) Melt some glue-size in a bottle; next get a piece of rag, roll it into a ball so that it will fit the hand nicely, cover this with a bit of old calico to make a smooth face; dip this into the size, and rub in a bit of brown umber; then go ahead with your floors, working the stuff light or dark as required. Keep the motion with the grain of wood; when dry, stiffen with polishers' glaze.

(6) Take Judson's dyes of the colour required, mix according to the instructions given with each bottle, and apply with a piece of rag, previously trying it on a piece of wood to see if colour would suit; rub with sandpaper to get off any roughness that may be raised with the damp, and varnish with fine pale hard varnish, then slightly sandpaper and varnish again. Another method is to boil 1 lb. logwood in an *old* boiler, then apply with a piece of rag where the stain is required; when thoroughly dry, sandpaper as before, and well rub with beeswax to polish. This last process looks best when finished, but it requires a lot of elbow grease for a few months, and is extremely durable. To prevent the stain running where you do not want it, paste some stiff paper.

Green.—(1) Mordant the wood with red liquor at 1° B. This is prepared by dissolving separately in water 1 part sugar of lead and 4 of alum free from iron; mix the solutions, and then add $\frac{1}{32}$ part of soda crystals, and let settle overnight. The clear liquor is decanted off from the sediment of sulphate of lead, and is then diluted with water till it marks 1° B. The wood when mordanted is dyed green with berry liquor and extract of indigo, the relative proportions of which determine the tone of the green.

(2) Verdigris dissolved in 4 parts water.

(3) 4 2 oz. copper, cut up finely, are gradually dissolved in 13 oz. nitric acid (aquafortis), and the articles to be stained are boiled in this solution until they have assumed a fine green colour.

Grey.—(1) Greys may be produced by boiling 17 oz. orchil paste for $\frac{1}{2}$ hour in 7 pints water. The wood is first treated with this solution, and then, before it is dry, steeped in a beck of nitrate of iron at 1° B. An excess of iron gives a yellowish tone; otherwise a blue grey is produced, which may be completely converted into blue by means of a little potash.

(2) 1 part nitrate of silver dissolved in 50 of distilled water; wash over twice; then with hydrochloric acid, and afterwards with water of ammonia. The wood is allowed to dry in the dark, and then finished in oil and polished.

Mahogany.—(1) Boil $\frac{1}{2}$ lb. madder and 2 oz. logwood chips in 1 gal. water, and brush well over while hot. When dry, go over with pearlash solution, 2 dr. to the quart. By using it strong or weak, the colour can be varied at pleasure.

(2) Soak 1 lb. stick varnish in 2 qt. water until all the colour is dissolved out; strain off the water, and add to the residue 25 dr. powdered madder. Set the mixture over the fire until it is reduced to $\frac{3}{4}$ of its original volume. Then mix together 25 dr. cochineal, 25 dr. kermes berries, 1 pint [illegible] wine, and $\frac{1}{2}$ oz. pearlash, out of which the colour has been washed by soaking in a gill of soft water. Add this mixture to the decoction of madder and varnish, stirring well together, and adding so much aquafortis as will bring

the red to the desired shade. (*Gewerbehalle.*)

(3) Dark Mahogany.—Introduce into a bottle 15 gr. alkanet root, 30 gr. aloes, 30 gr. powdered dragon's blood, and 500 gr. 95 per cent. alcohol, closing the mouth of the bottle with a piece of bladder, keeping it in a warm place for 3 or 4 days, with occasional shaking, then filtering the liquid. The wood is first mordanted with nitric acid, and when dry washed with the stain once or oftener, according to the desired shade; then, the wood being dried, it is oiled and polished.

(4) Light Mahogany.—Same as dark mahogany, but the stain being only applied once. The veins of true mahogany may be imitated by the use of acetate of iron skilfully applied.

(5) The following process is recommended in *Wiederhold's Trade Circular*:—The coarse wood is first coated with a coloured size, which is prepared by thoroughly mixing up, in a warm solution, 1 part commercial glue in 6 of water, a sufficient quantity of the commercial mahogany brown, which is in reality an iron oxide, and in colour stands between so-called English red and oxide of iron. This is best effected by adding in excess a sufficient quantity of the dry colour with the warm solution of glue, and thoroughly mixing the mass by means of a brush until a uniform paste is obtained, in which no more dry red particles are seen. A trial coat is then laid upon a piece of wood. If it is desired to give a light mahogany colour to the object, it is only necessary to add less, and for a darker colour more, of the brown body-colour. When the coat is dry, it may be tested, by rubbing with the fingers, whether the colour easily separates or not. In the former case, more glue must be added until the dry trial coat no longer perceptibly rubs off with the fingers. Having ascertained in this way the right proportion of the size colour with regard to the strength, it is then warmed slightly, and worked through [illegible] brush. After this, it is [illegible] upon the wood surface with the brush, which has been carefully washed. It is not necessary to keep the colour warm during the painting. Should it become thick by gelatinising, it may be laid on the wood with the brush, and dries more rapidly than when the colour is too thin. If the wood is porous and absorbs much colour, a second coat may be laid on the first when dry, which will be sufficient in all cases. On drying, the size colour appears dull and unsightly, but the following coat changes immediately the appearance of the surface. This coat is spirit varnish. For its production 3 parts spirits of wine of 90° are added in excess to 1 part of red acaroid resin in one vessel, and in another 10 parts shellac with 40 of spirits of wine of 80°. By repeated agitation for 3 or 4 days, the spirit dissolves the resin completely. The shellac solution is then poured carefully from the sediment, or, better still, filtered through a fine cloth, when it may be observed that a slight milky turbidity is no detriment to its use. The resin solution is best filtered into the shellac solution by pouring through a funnel loosely packed with wadding. When filtered, the solutions of both resins are mixed by agitating the vessel and letting the varnish stand a few days. The acaroid resin colours the shellac, and imparts to it at the same time the degree of suppleness usually obtained by the addition of Venetian turpentine or linseed-oil. If the varnish is to be employed as a coat, the upper layers are poured off at once from the vessel. One or two coats suffice, as a rule, to give the object an exceedingly pleasing effect. The coats dry very quickly, and care must be taken not to apply the second coat until the first is completely dry.

(6) 7·5 oz. madder, 8·75 oz. rasped yellow wood, are boiled for 1 hour in 5·5 lb. water, and the boiling liquor is applied to the articles until the desired colour has been produced.

(7) 1·05 oz. powdered turmeric, 1·05 oz. powdered dragons'-blood, are digested in 8·75 oz. of 80 per cent. strong alcohol, and when the latter

seems to be thoroughly coloured it is filtered through a cloth. The filtrate is heated and applied warm to the article.

(8) 17·5 oz. madder, 8·75 oz. ground logwood, are boiled for 1 hour in 5·5 lb. water. This is filtered while still warm, and the warm liquor is applied to the wood. When this has become dry, and it is desired to produce a darker mahogany colour, a solution of 0·525 oz. carbonate of potash in 4·4 lb. water is applied to the wood. This solution is prepared cold, and filtered through blotting-paper.

(9) 0·35 oz. aniline is dissolved in 8·75 oz. spirits of wine 90 per cent. strong. Then another solution of 0·35 oz. aniline yellow in 17·5 oz. spirit of wine 90 per cent. strong is made, and this is added to the aniline solution until the required reddish-yellow colour is obtained. By adding a little of a solution of aniline brown (0·35 oz. aniline brown in 10·5 oz. spirits of wine 90 per cent. strong), the colour is still more completely harmonised, and a tint very closely resembling mahogany can be given to elm and cherry wood with this mixture.

(10) 0·7 oz. logwood is boiled in 3·5 oz. water down to about ½. This is then filtered, and 0·12 oz. chloride of baryta is dissolved in it.

Oak.—(1) Mix powdered ochre, Venetian red, and umber, in size, in proportions to suit; or a richer stain may be made with raw sienna, burnt sienna, and vandyke. A light yellow stain of raw sienna alone is very effective.

(2) Darkening Oak.—Lay on liquid ammonia with a rag or brush. The colour deepens immediately, and does not fade; this being an artificial production of the process which is induced naturally by age. Bichromate of potash, dissolved in cold water and applied in a like manner, will produce a very similar result.

(3) In Germany, the cabinet-makers use very strong coffee for darkening oak. To make it very dark: iron filings with a little sulphuric acid and water, put on with a sponge, and allowed to dry between each application until the right hue is reached.

(4) Whitewash with fresh lime, and when dry brush off the lime with a hard brush, and dress well with linseed oil. It should be done after the wood has been worked, and it will make not only the wood, but the carving or moulding, look old also.

(5) Use a strong solution of common washing-soda, say one or two coats, until the proper colour is obtained. Or you may try carbonate of potash. Paper and finish off with linseed-oil.

(6) A decoction of green walnut-shells will bring new oak to any shade, or nearly black.

Purple. — (1) Take 1 lb. logwood chips, ¾ gal. water, 4 oz. pearlash, 2 oz. powdered indigo. Boil the logwood in the water till the full strength is obtained, then add the pearlash and indigo, and when the ingredients are dissolved the mixture is ready for use, either warm or cold. This gives a beautiful purple.

(2) To stain wood a rich purple or chocolate colour, boil ½ lb. madder and ¼ lb. fustic in 1 gal. water, and when boiling brush over the work until stained. If the surface of the work should be perfectly smooth, brush over with a weak solution of nitric acid; then finish with the following: put 4½ oz. dragon's blood and 1 oz. soda, both well bruised, into 3 pints spirits of wine. Let it stand in a warm place, shake frequently, stain and lay on with a soft brush, repeating until a proper colour is gained. Polish with linseed-oil or varnish.

(3) 2·2 lb. rasped logwood, 5·5 lb. rasped Lima red dyewood are boiled for 1 hour in 5·5 lb. water. It is then filtered through a cloth and applied to the article to be stained until the desired colour has been obtained. In the meanwhile a solution of 0·175 oz. carbonate of potash in 17·5 oz. water has been prepared, and a thin coat of this is applied to the article stained red. But strict attention must be paid not to apply too thick a coat of this solution, or else a dark blue colour would be the result.

Red.—(1) The wood is plunged first in a solution of 1 oz. of curd soap in 35 fl. oz. water, or else is rubbed with the solution; then magenta is applied in a state of sufficient dilution to bring out the tone required. All the aniline colours behave very well on wood.

(2) For a red stain, a decoction of ¼ lb. logwood and ½ oz. potash in 1 lb. water is used as the bath, being fixed by a wash of alum-water. For scarlet, use 1 oz. cochineal, 6 oz. powdered argol, 4 oz. cream tartar, in 12 oz. chloride of tin (scarlet spirits).

(3) Take 1 qt. alcohol, 3 oz. Brazil-wood, ½ oz. dragon's blood, ½ oz. cochineal, 1 oz. saffron. Steep to full strength and strain. It is a beautiful crimson stain for violins, work-boxes, and fancy articles.

(4) Besides the aniline colours, which are, however, much affected by sunlight, cochineal gives a very good scarlet red upon wood. Boil 2 oz. cochineal, previously reduced to a fine powder, in 35 oz. water for 3 hours, and apply it to the wood. When dry, give it a coating of dilute chloride of tin to which is added a little tartaric acid—1 oz. chloride of tin, and ½ oz. tartaric acid in 35 fl. oz. water. If, instead of water, the cochineal is boiled in a decoction of bark (2 oz. bark to 35 oz. water), and the chloride of tin is used as above, an intense scarlet and all shades of orange may be produced according to the proportions.

(5) Take 1 gal. alcohol, 1½ lb. camwood, ½ lb. red sanders, 1 lb. extract of logwood, 2 oz. aquafortis. When dissolved, it is ready for use. It should be applied in 3 coats over the whole surface. When dry, rub down to a smooth surface, using for the purpose a very fine paper. The graining is done with iron rust, and the shading with asphaltum thinned with spirits of turpentine. When the shading is dry, apply a thin coat of shellac; and when that is dry, rub down with fine paper. The work is then ready for varnishing—a fine rose tint.

(6) Monnier recommends steeping the wood for several hours in a bath of 1200 gr. iodide of potassium to the quart of water, and then immersing it in a bath of 375 gr. corrosive sublimate, when it will assume a beautiful rose-red colour by chemical precipitation. It should subsequently be covered with a glossy varnish. The baths will not need renewal for a long time.

(7) Rose.—Iodide of potash in 12 parts water for a first coat, and corrosive sublimate in 40 parts water for a second.

(8) 2·2 lb. finely-powdered Lima red dyewood and 2·1 oz. carbonate of potash are put in a glass bottle and digested in 5·5 lb. water for 8 days in a warm place; the bottle should be frequently shaken. It is then filtered through a cloth; the fluid is heated, and applied to the article to be stained until the latter acquires a beautiful colour. If it is desired to brighten the colour, a solution of 2·1 oz. alum, free from iron, in 2·2 lb. water is applied to the article while it is still wet. The last solution can be prepared by heat; when it has been accomplished, it is filtered. As soon as the stains have become dry, they should be rubbed with a rag moistened with linseed-oil, after which the varnish may be applied.

Satinwood.—Take 1 qt. alcohol, 3 oz. ground turmeric, 1½ oz. powdered gamboge. When steeped to its full strength, strain through fine muslin. It is then ready for use. Apply with a piece of fine sponge, giving the work 2 coats. When dry, sandpaper down very fine. It is then ready for polish or varnish, and is a good imitation of satinwood.

Violet.—The wood is treated in a bath made up with 4¼ oz. olive-oil, the same weight of soda-ash, and 2½ pints boiling water, and it is then dyed with magenta to which a corresponding quantity of tin crystals has been added.

Walnut.—Deal and other common woods are stained to imitate polished walnut in various ways. (1) One method is, after careful rubbing with glasspaper, to go over the surface with a preparation of Cassel brown boiled in a lye of soft soap and soda. After drying, the surface is rubbed over with pumice and oil, and polished with shellac. The Cassel brown will not take equally well on all kinds of wood, so that if not laid on thick it sometimes comes off under the subsequent pumicing; whilst on the other hand this same thickness conceals, more or less, the grain on the wood beneath, giving it the appearance of having been painted.

(2) Others use instead a decoction of green walnut-shells, dried and boiled in the same lye, or in soft water to which soda has been added. The decoction of walnut-shells is apt to come off on the clothes as a yellowish adhesive substance.

(3) Others, again, employ catechu and chromate of potash in equal parts, boiled separately and afterwards mixed. The mixture of catechu and chromate of potash leaves a reddish-brown deposit on the surface of the wood, very unlike real walnut.

(4) The following is said to be a very superior method for staining any kind of wood in imitation of walnut, while it is also cheap and simple in its manipulation. The wood, previously thoroughly dried and warmed, is coated once or twice with a stain composed of 1 oz. extract of walnut peel dissolved in 6 oz. soft water by heating it to boiling, and stirring. The wood thus treated, when half dry, is brushed with a solution of 1 oz. bichromate of potash in 5 oz. boiling water, and is then allowed to dry thoroughly, and is to be rubbed and polished as usual. Red beech and alder, under this treatment, assume a most deceptive resemblance to American walnut. The colour is fixed in the wood to a depth of one or two lines.

(5) Mix dragon's blood and lampblack in methylated spirits till you get the colour required, and rub it well into the grain of the wood.

(6) Light Walnut.—Dissolve 1 part permanganate of potassium in 30 of pure water, and apply twice in succession; after an interval of 5 minutes, wash with clean water, and when dry, oil and polish.

(7) Dark Walnut.—Same as for light walnut, but after the washing with water the dark veins are made more prominent with a solution of acetate of iron.

(8) In the winter season get some privet berries (black), which grow in most gardens, and put 2 oz. in ½ pint solution of liquid ammonia. This, applied to pine varnished or polished, cannot be detected from real walnut itself.

(9) Take 1 gal. very thin sized shellac; add 1 lb. dry burnt umber, 1 lb. dry burnt sienna, and ¼ lb. lampblack. Put these articles into a jug and shake frequently until they are mixed. Apply one coat with a brush. When the work is dry, rub down with fine paper, and apply one coat of shellac or cheap varnish. It will then be a good imitation of solid walnut, and will be adapted for the back boards of mirror-frames, for the back and inside of casework, and for similar work.

(10) Take 1 gal. strong vinegar, 1 lb. dry burnt umber, ½ lb. fine rose-pink, ½ lb. dry burnt vandyke brown. Put into a jug and mix well; let the mixture stand one day, and it will then be ready for use. Apply this stain to the sap with a piece of fine sponge, it will dry in ½ hour. The whole piece is then ready for the filling process. When the work is completed, the stained part cannot be detected even by those who have performed the job. By means of this recipe, wood of poor quality and mostly of sap can be used with good effect.

(11) Darkening Walnut. — Slaked lime, 1 to 4 of water, will do for some kinds of walnut; a weak solution of sulphate of iron for others; and yet again for other kinds a weak solution of pearl-ash. Try each on the wood, and choose the one you like best.

(12) To give to walnut a dark colour resembling rosewood, Hirschberg uses a solution of 0·17 oz. bichromate of potash in 1·05 oz. water. This solution is applied to the walnut with a sponge, and the wood is then dried and polished.

(13) By a simple staining furniture of pine or birch wood can be easily made to appear as if it had been veneered with walnut veneer. For this a

solution of 3·15 oz. manganate of potash, and 3·15 oz. sulphate of manganese in 5·25 qt. hot water, is made. This solution is applied to the wood with a brush, and must be repeated several times. The manganate of potash is decomposed when it comes in contact with the woody fibre, and thus a beautiful and very durable walnut colour is obtained. If small wooden articles are to be stained in this manner, a very diluted bath is prepared; the articles are dipped into it, and kept there 1 to 9 minutes according as the colour is desired lighter or darker.

Yellow.—(1) Mordant with red liquor, and dye with bark liquor and turmeric.

(2) Turmeric dissolved in wood naphtha.

(3) Aqua regia (nitro-muriatic acid), diluted in 3 parts water, is a much-used though rather destructive yellow stain.

(4) Nitric acid gives a fine permanent yellow, which is converted into dark brown by subsequent application of tincture of iodine.

(5) Wash over with a hot concentrated solution of picric acid, and when dry, polish the wood.

(6) Orange-yellow Tone to Oak Wood.—According to Niedling, a beautiful orange-yellow tone, much admired in a chest at the Vienna Exhibition, may be imparted to oak-wood by rubbing it in a warm room with a certain mixture until it acquires a dull polish, and then coating it after an hour with thin polish, and repeating the coating of polish to improve the depth and brilliancy of the tone. The ingredients for the rubbing mixture are about 3 oz. tallow, ¾ oz. wax, and 1 pint oil of turpentine, mixed by heating together and stirring.

(7) 0·5 oz. nitric acid (aquafortis) [illegible] compounded with 1·57 oz. rain-water, and the article to be stained is brushed over with this. Undiluted nitric acid gives a brownish-yellow colour.

(8) 2·1 oz. fine[illegible]ed turmeric are digested for sev[illegible] 17·5 oz. alcohol 80 per cent [illegible] strained through a cloth. This solution is applied to the articles to be stained. When they have become entirely dry, they are burnished and varnished.

(9) 1·57 oz. carbonate of potash are dissolved in 4·2 oz. rain-water. This solution is poured over 0·52 oz. annatto, and this mixture is allowed to stand for 3 days in a warm place, being frequently shaken in the meanwhile. It is then filtered, and 0·175 oz. spirit of sal-ammoniac is added to it. The stain is now ready, and the articles to be stained will acquire a very beautiful bright yellow colour by placing them in it.

(10) Bright Golden Yellow.—0·52 oz. finely-powdered madder is digested for 12 hours with 2·1 oz. diluted sulphuric acid, and then filtered through a cloth. The articles to be stained are allowed to remain in this fluid 3 to 4 days, when they will be stained through.

Wool.—*Amaranth.*—On Yarns and Pieces. Boil 87 dr. orchil in water, and make up the decoction to 1¾ pint. Boil 30 dr. cochineal in water, and make up the decoction to 1 pint. Thicken the mixture with ½ lb. starch. Stir till cold, and add, whilst constantly stirring, 25 dr. ground alum, 12½ dr. perchloride of tin. When thoroughly mixed together, print, steam, and rinse.

Black.—On 50 lb. Flocks, resisting the fulling-mill. 20 lb. logwood, 7 lb. yellow-wood, 6 lb. sumach, 2½ lb. tartar. Boil the wool in this bath for 2 hours, then replace the evaporated water, and wet the wool, continually shaking it, with the solution of 2½ lb. sulphate of iron, 1½ lb. sulphate of copper. Boil for an hour. For a bluish black, wet the wool as above, as soon as it is lukewarm, with 2 lb. ammoniac, and then rinse and dry it well. For a deep black, substitute for ammoniac 1½ lb. bichromate of potash, dissolve it in boiling water, and boil for ¼ hour.

Blue.—(1) Woad on yarn (10 lb.) Boil ½ hour with 167 dr. alum, 80 dr. argol, 50 dr. extract of indigo. Take out, let half the contents of the pan run off, fill up with cold water, and dye at

122° F. (50° C.) with 2 to 3 lb. logwood.

(2) On 15 lb. Wool spun for Knitting. Mordant by boiling 1 hr. in a bath containing 1 lb. alum, 1 lb. tartar, ½ lb. indigo carmine, 2½ oz. tin salt. Take out the wool, and let half the bath flow away, replacing by cold water. Dye at 112° F. (50° C.) with 2½ lb. logwood.

(3) Deep Blue on 50 lb. Flocks of Wool, resisting the fulling-mill. Give a ground of blue, rinse in hot water, and mordant for an hour in a boiling bath containing ¼ lb. bichromate of potash, 5 lb. alum. ¼ lb. copper, 2½ oz. tin salt; then dye with the addition of ¼ lb. sulphuric acid, rinse, and dry.

(4) Logwood Blue. Wool can be dyed with logwood or false blue by several processes which recommend themselves by their cheapness and simplicity. Old dyers used to dye in a single bath, whilst now-a-days the process consists of one mordanting either at cold or hot, and to dye in a solution of the dyeing matter. The colour is fixed on the wool by means of different salts with which it is impregnated before dyeing, and which render the colouring matter insoluble in water when fixed on the fibre. The two following processes are in use in Aix-la-Chapelle:—

(*a*) Middle Blue on 100 lb. Wool. Boil for 2 hours in water: sulphate of soda, 10 lb.; tartar, 6 lb.; tin crystals, 3 oz.; sulphuric acid, 8 oz. Leave the wool during the night, then dye with logwood, 40 lb., carbonate of soda, 1 lb.

(*b*) Violet Blue on 100 lb. Wool. Boil for 1½ hour with sulphate of soda, 8 lb.; tin crystals, 2 lb.; tartar, 4 lb. Then dye with logwood, 30 lb.; orchil, 5 lb.; sulphate of copper, 4 lb.

(5) Pensée. 4 lb. orchil 13° B. (brand B), 12 oz. gum-senegal.

(6) Mode. 4 lb. cachou extract 2° B., 2½ oz. ammoniacal cochineal, 2½ oz. indigo acetate; thicken with 8 lb. of the thickening given in grey (1).

(7) Mode. 2lb. cachou extract, 2° B.; heat and pour over 12 oz. gum-senegal, 1½ oz. alum, ¾ oz. tartaric acid.

Green.—(1) Solid Green on 100 lb. Wool. Dye in the following bath: alum, 15 lb.; sulphuric acid, 5 lb.; sulphate of indigo, 5 lb.; picroline, 12 oz.

(2) Fresh Green on 100 lb. Wool. Dye bath: sulphate of soda, 12½ lb.; sulphuric acid, 7½ lb.; carmine of indigo, 7½ lb.; picroline, 1 lb.

(3) Vert possé (fast green) on 25 lb. Wool. Glauber salt, 1½ lb.; sulphate of alumina, 1½ lb.; sulphate of indigo, 1 lb.; orchil, 1 lb.; turmeric, 4 lb. Boil in this bath for 1½ hour.

(4) Feuille morte (dead leaf) on 25 lb. Wool. Sulphate of alumina, 1½ lb.; sulphate of soda, 1½ lb.; sulphate of indigo, 1 lb.; orchil 3 lb., or orchil extracts, 1 lb.; turmeric, 2 lb. Boil in this bath for 1½ hour.

(5) Feuille séche (dried leaf), on 25 lb. Wool. Sulphate of soda, 1½ lb.; sulphate of alumina, 1½ lb.; sulphate of indigo, ½ lb.; orchil, 3 lb., or orchil extract, 1 lb.; turmeric, 1½ lb. Boil in this bath for 1½ hour.

(6) 14½ oz. white starch, 2½ lb. water, 9 lb. Cuba lac; boil; add when warm, 5 oz. indigo carmine; mix well; decant the colour; add whilst tepid, 5 oz. oxalic acid; and when cold, 7½ oz. alumina sulphate.

(7) 2 lb. malachite green solution, 5 per cent.; 2 lb. gum substitute water, 65 per cent.

Grenade.—(1) Steam Grenade (fast). Colour: orchil, 14° B., 6 lb. 4 oz.; extract quercitron, 20° B., 8 oz.; gum thickening, 1 lb. 8 oz. After boiling, add: alum, 3 oz.; tartaric acid, ½ oz.; indigo carmine, 1½ oz. (2) Bordeaux R.

Grey.—(1) Pearl Grey. Colour: ammoniacal cochineal, 3° B., 2½ oz.; acetate of indigo, 10° B., 1½ oz.; 2 lb. 8 oz. of the following thickening: gum water, 12 lb.; alum, 12 oz.; tartaric acid, 1¾ oz. (2) Induline.

Maroon.—On 50 lb. Wool, resisting the fulling-mill. Prepare a dyeing bath as follows: to a clear solution of 10 lb. catechu add 2 lb. logwood and 2½ lb. tartar. Boil the wool for 2 hours in this bath, rinse, and add to the above bath 2 lb. bichromate of potash and 1 lb. sulphate of copper. Put the wool in, and boil for ½ to 1 hour, according to the shade required, and then rinse.

Olive.—(1) On Yarn (10 lb.). Boil with 96 dr. prepared tartar, 20 dr. blue vitriol, 375 dr. orchil, 50 dr. turmeric, 40 dr. indigo sulphate. Cerise as required.

(2) Fast Light on 100 lb. Yarn. Half fill the vat with water, bring to boil, and dissolve 2 lb. fast yellow, 4½ oz. fast brown, 7½ oz. light green S., 3 oz. induline, and then 40 lb. tartar composition, 10 lb. Glauber salt. Fill the vat with water, enter yarn, boil 1 hour, wash and dry. This colour remains olive also by artificial light.

(3) On 15 lb. wool. Boil with 1 lb. potash bisulphate, 1¾ oz. copper sulphate, 2½ lb. orchil, ¾ lb. turmeric, ¼ lb. indigo sulphate, and garnet according to shade required.

Orange.—(1) Alizarine on 150 lb. Wool. Boil for 1¼ to 1½ hour in the following bath, containing: alum, 7½ lb.; tartar, 12½ lb.; tin crystals, 2½ oz.; and alizarine W., 15 lb.

(2) Printing. Colour: Persian berries decoction, 9° B., 4 lb.; gum-senegal, 1 lb. 2 oz.; alum, 4 oz.; tin crystal, 4 oz.; oxalic acid, 1 oz.

Ponceau.—(1) 1 lb. cochineal decoction, 5° B., 1½ lb. white starch; boil well; add when lukewarm, 9 oz. oxalic acid, 1½ oz. tin crystals, 3 oz. double tin chloride. (2) 2 lb. solution of ponceau R., containing 4 per cent., 2 lb. solution of gum substitute, containing 65 per cent.

Puce.—Steam Puce (fast). Colour: orchil, 12° B., 4 lb. 8 oz. Heat and dissolve in it by small quantities, after taking away from the fire: alum, 1 oz.; tartaric acid, ¼ oz.; thicken with white starch, 3 oz.; gum, 2 oz.; then add indigo carmine, ¼ oz.

Red.—(1) Fire Red on Yarns and Piece Goods. 5¼ pints cochineal extract at [illegible] B., 157 dr. starch; boil well together, and add 12½ dr. oxalic acid. Stir till cold, and add, whilst constantly stirring, 12½ dr. tin crystals, and 25 dr. berry liquor [illegible] Mix perfectly, print, steam 1 hour, rinse.

(2) Scarlet on 120 lb. Wool. Dissolve in boiling water: liquid extract of *quercitron*, 3 *lb.* 8. *oz.*; *oxalic acid*, 3 lb. 8 oz.; tin crystals, 1 lb. 12 oz.; tartar, 4 lb.; cochineal, 4 lb.; chloride of tin solution, 8 lb. Mix well when dissolved, add cold water, enter wool, and boil for 1 to 1½ hour.

Violet.—(1) 4 lb. orchil, 13° B. (brand M); 12 oz. gum-senegal.

(2) Colour: water, 10 lb.; ammoniacal cochineal, 3° B., 20 lb.; white starch, 3 lb. 8½ oz; boil, and add when warm—oxalic acid, 4½ oz.; alum, 1 lb. 8½ oz.; deuto-chloride of tin, 1¼ oz.

Wood-colour.—Steam. Colour: orchil, 10° B., 10 lb.; cambresine decoction, 10° B., 10 lb. Thicken with gum thickening, 4 lb.; and add after taking away from the fire—alum, 1 lb.; oxalic acid, 3⅜ oz.; sulphate of iron, 3¼ oz. The cambresine decoction is obtained by boiling 3 different times—fustic, 2 parts; Persian berries, 1 part, in water, and mixing together the 3 decoctions, which are then reduced to 10° B.

ESSENCES.—The term essence implies a preparation of the essentially active portion of a substance, but it is widely and erroneously applied to a variety of decoctions, infusions, solutions, tinctures, and fluid extracts, as well as the alcoholic solutions of essential oils from plants. In preparing essences, the solid ingredients must be thoroughly bruised, powdered, or sliced, so as to expose them completely to the action of the spirit. When the active principle to be obtained is partly fixed and partly volatile, the most suitable process is simple digestion in alcohol, either weak or absolute, according to the solubility of the substance. The digestion or maceration should be continued for at least 10–14 days, and the materials should be repeatedly agitated, so as to ensure contact between all fragments. A more concentrated solution may be obtained by the process of displacement or percolation. When the object is to extract only an aromatic and volatile principle, a better method is to digest the materials in alcohol for a few days, and then subject the whole to distillation: the alcohol passes over in vapour, carrying with it the bulk of the volatile matters vaporizable at or below the distillation temperature of the alcohol employed. For all first-class articles, the alcohol used must be pure, and free from colour, odour, and flavour. The following are amongst the most important essences in use.

Aconite.—8 oz. dried powdered aconite herb, 16 oz. rectified spirit; macerate 4 days at 68° F. (20° C.), press, strain; the marc or residue is again macerated with a little spirit and pressed as before, so that the weight of the united tinctures may be double that of the herb.

Allspice.—1 fl. oz. essential oil of allspice (pimento), 1 pint strongest rectified spirit; agitate till perfectly mixed; next day decant the clear from the sediment.

Almonds.—(1) 1 fl. oz. essential oil of almonds, 1 pint spirit; proceed as Allspice.

(2) 1 fl. oz. essential oil, 7 fl. oz. spirit.

Ammoniacum.—(1) 1 lb. ammoniacum in tears, bruised in a cold mortar with ½ lb. coarse, well-washed, silicious sand or powdered glass, and ½ pint rectified spirit gradually added; trituration is continued till the whole is reduced to smooth paste, and it is then placed in a wide-mouthed bottle with ½ pint spirit of wine; digest for a week with frequent stirring, and after allowing to settle, decant the clear into another bottle for use.

(2) Reduce 1 lb. ammoniacum to a cream with ¾ pint boiling water; as soon as cool, put into a strong bottle, and cautiously add 1¼ pint rectified spirit of wine; cork tightly, and let macerate for a few days; put the bottle in a warm place for the sediment to go down, and filter off through flannel.

Anchovy.—(1) 1 lb. anchovies, boned, pulped in a stone mortar, and passed through a hair or wire sieve; boil the bones and the portion that will not go through the sieve in 1 pint water for 15 minutes, and strain; to the strained liquor add 2½ oz. each of salt and flour, as well as the pulp, and simmer the whole for 3 or 4 minutes; remove from the fire, cool, and mix in ½ pint strong pickling vinegar; bottle, and secure with wax, capsule, or bladder.

(2) 7 lb. anchovies, 9 pints water, 1 lb. flour, 1 lb. salt.

(3) Add ¼ oz. cayenne pepper, 4 oz. mushroom ketchup, and the grated peel of a lemon to (2). Cochineal or annatto may be used for colouring.

Angelica.—1 oz. bruised angelica root, 8 oz. rectified spirit, 16 oz. water; digest, and distil over 6 oz.

Aniseed.—1 oz. oil of anise, 8 oz. rectified spirit.

Anodyne.—(1) 1 dr. powdered hard aqueous extract of opium, ½ dr. powdered cinnamon, 1 fl. oz. rectified spirit; digest a week.

(2) 5 dr. recent extract of henbane, 2 fl. oz. rectified spirit; digest a week.

Antihysteric.—3 gr. potassium cyanide, 1 dr. powdered sugar, 4 fl. dr. rectified spirit, 4 fl. dr. orange-water; shake together till dissolved.

Aromatic.—1 dr. hay saffron, 6 fl. dr. rectified spirit; digest together, filter; to filtrate add 1 dr. oil of cinnamon, 1 dr. powdered white sugar, 2 fl. dr. rectified ether, ½ dr. oil of nutmeg, ½ dr. essence of ginger; after shaking and a few days' repose, decant the clear.

Bark.—(1) 4 dr. resinous extract of yellow bark, 1½ fl. oz. rectified spirit, ½ fl. oz. tincture of orange-peel, 1 fl. dr. acetic acid; digest a week.

(2) ½ dr. quinine disulphate, 2 dr. resinous extract of bark, 2 fl. oz. rectified spirit; digest a week.

Beef.—(1) 1 lb. lean beef chopped small, ½ pint water; put into large bottle and shake violently ½ hour; strain the liquid into a jug; boil the solid residue in 1 pint water for 20 minutes; strain, and add the liquid to the previous cold infusion; evaporate to consistence of thin syrup, add salt and spice to taste, and while boiling hot pour into cans or (previously heated) bottles, hermetically seal, and store in a cold place.

(2) Boil the sliced beef and water in a bottle suspended in water in a pot for

1 or 2 hours; decant the liquid, skim, and flavour.

Bitter.—4 oz. wormwood, 1 oz. gentian root, 1 oz. bitter orange-peel, 1 oz. blessed thistle, 45 oz. rectified spirit: digest a week.

Camphor.—(1) 4½ oz. clean camphor dissolved in 1 gal. rectified spirit.

(2) 1 oz. camphor, 10 oz. rectified spirit.

(3) 13 fl. dr. tincture of camphor, ½ fl. dr. tincture of myrrh, 18½ fl. dr. rectified spirit.

(4) 1 fl. oz. spirit of camphor, 7 fl. oz. proof spirit.

(5) 1 dr. camphor dissolved in 2½ oz. rectified spirit; add ½ oz. water.

(6) 1 dr. powdered camphor dissolved in 12 fl. oz. water saturated with carbonic acid gas.

Caraway.—As Allspice.

Cardamom.—5½ lb. lesser cardamom seeds ground in a pepper-mill, 1 gal. rectified spirit of wine; digest for a fortnight, press, filter.

Cascarilla.—12 oz. bruised cascarilla, 1 pint proof spirit; proceed by digestion or percolation.

Cassia.—As Allspice.

Cayenne.—(1) 3 lb. recently-dried capsicum pods, 1 gal. rectified spirit; digest 14 days, press, filter.

(2) ¼ lb. capsicum, 1 pint proof spirit; digest, press, filter.

(3) 1 oz. cayenne pepper, 1 pint brandy; digest, press, filter.

Celery.—(1) 4½ oz. bruised celery seed, 1 pint proof spirit; digest 14 days, strain.

(2) 7 oz. celery seed, 1 pint rectified spirit; digest and strain as (1).

Chamomile.—(1) As Allspice.

(2) 1 lb. sliced or bruised gentian root, ¼ lb. dried orange-peel, 1 gal. proof spirit, 3½ fl. oz. essential oil of chamomile; macerate a week.

(3) ½ lb. quassia wood may replace the gentian and orange-peel.

Cinnamon.—(1) As Allspice.

(2) [illegible] oz. cinnamon, ¾ pint rectified spirit, [illegible] pint water; digest a week, strain.

Cloves.—(1) As Allspice.

(2) 3½ oz. bruised cloves, 1 pint proof spirit, ¼ pint water; digest a week, strain.

Cochineal.—2 oz. cochineal, 2 oz. subcarbonate of potash, 2 oz. potash alum, 2 oz. cream of tartar, 20 oz. distilled water. Boil the cochineal and potash together for about 10 minutes, then stir in gradually the cream of tartar and alum; *strain through muslin, and afterwards filter through paper.* To the filtrate add ½ lb. lump sugar, and dissolve with gentle heat.

Coffee.—4 oz. coffee, 2 oz. chicory, 1 oz. caramel (burnt sugar); prepared by percolation of the coffee with boiling water, gently and quickly evaporated to ⅓ or ¼ its bulk, adding a thick aqueous extract of the chicory and syrup of *burnt sugar, so as to* give the whole a treacly consistence.

Coltsfoot.—(1) 1 oz. tolu balsam, 3 oz. rectified spirit, 3 oz. compound tincture of benzoin; dissolve; in a few days decant the clear.

(2) 1 oz. tolu balsam, 1 oz. compound tincture of benzoin, 2 oz. rectified spirit.

(3) *5 fl. oz. tincture of tolu, 3 fl. oz.* compound tincture of benzoin, 1 oz. quite dry powdered sugar, 1 dr. hay saffron; digest a week, with frequent shaking.

Cubebs.—½ lb. bruised or ground cubebs, 1 pint rectified spirit; digest 14 days, press, filter.

(2) 4¼ lb. cubebs, 1 gal. rectified spirit.

(3) *Oleo-resinous.*—1 oz. oleo-resinous extract of cubebs dissolved in 3 oz. rectified spirit.

Dill.—(1) As Allspice.

(2) ½ oz. oil of dill, ½ oz. extract of dill, 1 oz. salt of tartar, 1 pint rectified spirit; digest, strain.

Ergot.—(1) 2 oz. powdered ergot, 2 fl. oz. rectified sulphuric ether; digest a week, express the tincture, filter, and abandon the liquid to spontaneous evaporation; dissolve the residue in 1 fl. oz. ether.

(2) 8 oz. ground ergot, 16 fl. oz. ether; prepare a tincture as (1), and by gentle heat distil off the ether in a retort connected with a well-cooled

refrigerator until 15 fl. oz. have passed; continue this evaporation at a reduced heat until the remainder of the ether has escaped; as soon as cold, dissolve the residue in 4 fl. oz. ether.

Fennel.—As Allspice.

Fruit, Artificial. — Kletzinsky published years ago formulas for 15 fruit essences, which, in 1867, were republished by several journals. Some of these formulas were again produced in the *Confectioners' Journal* without any alterations, except that in the essence of apple the quantity of oxalic acid was reduced from 1 to ¼ part, and glycerine from 4 to 2 parts; in essence of raspberry, the succinic acid was entirely omitted, and essence of peach was directed to be made of 2 oz. oil of bitter almonds, 1 oz. acetic ether, and 2 pints alcohol; but the latter product has evidently the flavour of peach kernels accompanied by a slight fruit odour. The flavour of peach fruit may be imitated by using 5 parts each acetic-butyric and amylacetic ethers, ½ (or less) of methyl-salicylic ether (oil of wintergreen), 2 or 3 parts oil of bitter almonds, and 80 or 100 of alcohol.

Kletzinsky's formulas for the extracts of strawberry and raspberry are much improved by adding 10 to 20 per cent. of tincture of orris root. If desired, the rather acrid taste of this tincture may be removed by precipitating the resin, and if solution of lead acetate is used for this purpose, the filtrate should be carefully freed from any excess of lead by sulphuretted hydrogen, or by agitation with solution of sodium sulphate, which salt, being insoluble in the alcoholic liquid, will not impart its peculiar saline taste. The tincture of orris may probably be conveniently replaced by an alcoholic solution of the oil of orris, which has been an article of commerce for some years past.

Since several very important errors had crept into the formulas of Kletzinsky as published in 1867, some of which are, however, readily corrected, it has been thought best to republish all the formulas from Wittstein's 'Vierteljahresschrift,' xvi. p. 268. These formulas are given in parts by measure for 100 parts alcohol, and whenever acids are used, they are to be previously dissolved in alcohol.

Apple.—Aldehyde, 2 parts; chloroform, acetic ether, nitrous ether, and oxalic acid, each 1; glycerine, 4; amyl-valerianic ether, 10.

Apricot.—Butyric ether, 10; valerianic ether, 5; glycerine, 4; amylic alcohol, 2; amyl-butyric ether, chloroform, œnanthic ether, and tartaric acid, each 1.

Banana.—Consists usually of butyric ether and amyl-acetic ether, equal parts, dissolved in about 5 parts alcohol.

Blackberry.—Tincture of orris root (1 to 8), 1 pint; acetic ether, 30 drops; butyric ether, 60 drops.

Black Cherry.— Benzoic ether, 5; acetic ether, 10; oil of persico (peach kernels) and benzoic acid, each 2; oxalic acid, 1.

Cherry.—Benzoic ether, acetic ether, each 5; glycerine, 3; œnanthic ether and benzoic acid, each 1.

Currant.—Acetic ether, tartaric acid, each 5; benzoic acid, succinic acid, benzoic ether, aldehyde, and œnanthic acid, each 1.

Grape.—Œnanthic ether, glycerine, each 10; tartaric acid, 5; succinic acid, 3; aldehyde, chloroform, and formic ether, each 2, and methyl - salicylic ether, 1.

Lemon.—Oil of lemon, acetic ether, and tartaric acid, each 10; glycerine, 5; aldehyde, 2; chloroform, nitrous ether, and succinic ether, each 1.

Melon.—Sebacylic ether, 10; valerianic ether, 5; glycerine, 3; butyric ether, 4; aldehyde, 2; formic ether, 1.

Nectarine. — Extract of vanilla, 2 parts; essence of lemon, 2; essence of pineapple, 1.

Orange.—Oil of orange and glycerine, each 10; aldehyde and chloroform, each 2; acetic ether, 5; benzoic ether, formic ether, butyric ether, amyl-acetic ether, methyl-salicylic ether, and tartaric acid, each 1.

Peach. — Formic ether, valerianic ether, butyric ether, acetic ether, glycerine, and oil of persico, each 5; aldehyde and amylic alcohol, each 2; sebacylic ether, 1.

Pear.—Acetic ether, 5; amyl-acetic ether and glycerine, each 2.

Pine apple.—Amyl-butyric ether, 10; butyric ether, 5; glycerine, 3; aldehyde and chloroform, each 1.

Plum.—Glycerine, 8; acetic ether and aldehyde, each 5; oil of persico, 4; butyric ether, 2; formic ether, 1.

Raspberry.—Acetic ether and tartaric acid, each 5; glycerine, 4; aldehyde, formic ether, benzoic ether, butyric ether, amyl-butyric ether, acetic ether, œnanthic ether, methyl-salicylic ether, nitrous ether, sebacylic ether, and succinic acid, each 1.

Strawberry.—Butyric ether and acetic ether, each 5; amyl-acetic ether, 3; amyl-butyric ether, and glycerine, each 2; formic ether, nitrous ether, and methyl-salicylic ether, each 1.

The different manufacturers of artificial fruit essences doubtless prepare them by formulas of their own, and this explains the difference in the flavour, which is particularly noticeable on largely diluting them with water. If the essences have been prepared with a dilute alcohol, their colour is more prominent, and they are apparently stronger; but on mixing a small quantity with a large amount of water in given proportions, the true flavouring strength may be better discerned.

The red colour of strawberry and raspberry essences is produced by aniline red (fuchsine), the bluish tint of which is conveniently neutralized by a little caramel. If caramel alone is used for colouring essence, a yellow or brown colour is obtained, according to the quantity used. (Maisch, *Amer. Jl. Pharm.*)

Ginger.—(1) 5 oz. bruised unbleached Jamaica ginger, 1 pint rectified spirit; digest a fortnight, press, filter.

(2) As (1) with addition of very little essence of cayenne.

(3) 3 oz. grated ginger, 2 oz. fresh lemon-peel, digested in 1½ pint brandy for 10 days.

(4) Equal parts best unbleached Jamaica ginger in coarse powder, and silicious sand, sprinkled with enough rectified spirit of wine to perfectly moisten; after 24 hours, the mass is placed in a percolator, and after returning the first runnings 2 or 3 times, the receiver is changed, and more rectified spirit is poured on gradually and at intervals as required, until as much essence is obtained as there has been ginger employed.

(5) 12 lb. best unbleached Jamaica ginger in coarse powder digested in 2½ gal. rectified spirit for 14 days; the expressed and strained tincture is reduced by distillation in a steam or water bath to 1 gal., cooled, transferred rapidly to stoppered bottles, and filtered.

(6) 24 lb. ginger as in (5), 6 gal. rectified spirit; make a tincture as before, and distil down to 1 gal.; cool as quickly as possible out of contact with the air, and add 1 gal. strongest rectified spirit of wine; filter if necessary.

(7) Causes no turbidity with water or syrup. 1 lb. finest Jamaica ginger in powder, macerated in 8 oz. rectified spirit for several hours; add more spirit, and percolate to 16 oz.; add 2 oz. heavy carbonate of magnesia, agitate, and add 24 oz. water; shake well, and filter. If the filtrate is turbid, shake up with more magnesia, and filter again. It becomes turbid again after a few days' rest, but on filtering continues clear. (Thresh.)

(8) As (7) entails a loss of active principle in the magnesia precipitate, Thresh gives the following modification: take 1 pint strong tincture (1 to 1) finest Jamaica ginger; add in small portions at a time finely-powdered slaked lime, shaking vigorously after each addition until nothing further is precipitated; throw the whole on a filter, and pass proof spirit through the residue until the product measures 2 pints. Add dilute sulphuric acid drop by drop until the rich yellow colour of the tincture suddenly disappears; let stand 24 hours, filter, dilute with water

to 4 pints, shake with a little powdered pumice or silica, and filter at 32° F. (0° C.) if possible.

Guaiacum.—3 cwt. recent guaiacum shavings from which the dust has been sifted, exhausted by coction in water, as in the preparation of an extract, using as little fluid as possible. The decoction is evaporated to exactly 1¾ gal., stirred until cold, to prevent the deposit of resinous matter, and put into a bottle with 5 pints spirits of wine; the whole is repeatedly agitated for a week, allowed to settle for 7 or 8 days, and the clear portion is decanted into another bottle.

Headache.—(1) 1 dr. oil of lavender (Mitcham), 1 oz. camphor, 4 oz. liquor ammoniæ, 1 pint rectified spirit; dissolve.

(2) 2 lb. spirit of camphor, 4 oz. strong water of ammonia, ½ oz. essence of lemon.

(3) 2 oz. camphor, 2 oz. liquor of ammonia, 4 dr. oil of lavender, 14 oz. rectified spirit. Very fragrant, stimulant, and rubefacient.

(4) 2 lb. spirit of wine, 2 oz. roach alum, 4 oz. camphor, ½ oz. essence of lemon, 4 oz. strong water of ammonia, in a close-stoppered bottle; shake daily for 3 or 4 days.

Hop.—(1) 26½ oz. new hops (rubbed small), 1 qt. proof spirit; digest 24 hours, then distil 1 pint over (quickly), and set the distillate aside in a corked bottle; to the residue add 1 pint water, boil 15 minutes, cool, express the liquor, strain, and evaporate as quickly as possible to dryness by a water bath; powder the residue, and add to the distilled spirit; digest a week, and filter.

(2) 5 oz. lupulinic grains (yellow powder, or lupulin of the strobiles), 1 pint rectified spirit; digest 10 days, express, and filter. Both are powerfully bitter, and laden with the aroma of the hop.

(3) Several noxious preparations under the name of "extract of hops" are sold by the brewers' druggist. They are mostly semi-fluid extracts of quassia, gentian, and like powerful bitters. Of 3 of these articles which were exposed by Cooley, one (for pale ale) consisted of the mixed extracts of quassia and chamomile; another was a preparation of picric acid; whilst a third (strongly recommended for porter) consisted of about equal parts of the extracts of bitter aloes, *Cocculus indicus*, and wormwood. A few years ago one of these vile compounds was publicly advertised and warranted as being equal to 100 times its weight in hops (1 oz. to 5½ lb.)

Lemon.—1 fl. oz. fresh oil of lemons, 8 fl. oz. deodorized alcohol (strongest flavourless rectified), ½ oz. exterior yellow rind of lemons (fresh); digest 48 hours, and filter.

Lemon-peel.—(1) ½ lb. yellow peel of fresh lemons, 1 pint spirit of wine; digest for a week, press, and filter.

(2) 1 lb. yellow peel of fresh lemons, ½ gal. boiling water; infuse 1 hour, express the liquor, boil down to ½ pint, cool, and add ¼ oz. oil of lemon dissolved in 1½ pint spirit of wine; mix, and filter.

Lovage.—2 oz. lovage root, 1 oz. lovage seeds, 10 oz. rectified spirit; digest a week and filter.

Nutmeg.—As Allspice.

Orange.—As Lemon.

Orange-peel.—4 oz. fresh yellow rind of orange, ½ pint rectified spirit, ½ pint water; digest for a week, press, filter; add 1 qt. sherry.

Pennyroyal.—As Peppermint.

Peppermint.—(1) 1 oz. oil of peppermint, 4 oz. rectified spirit; mix.

(2) To (1) add ½ oz. herb of peppermint, or parsley or spinach leaves (preferably one of the first two), digest for a week, or until sufficiently coloured; 10 or 12 gr. sap green rubbed up with a teaspoonful of hot water, is also used for colouring.

(3) 2 fl. oz. oil of peppermint, 16 fl. oz. rectified spirit.

Quassia.—(1) Digest 1½ oz. sliced quassia in 1 pint proof spirit for 10 days, and filter.

(2) Equal parts powdered quassia (sprinkled with a little rum) and "foot" sugar, reduced to the consistence of a

semifluid extract by the addition of a few spoonfuls of water.

(3) 1 oz. powdered quassia, 2 oz. burnt sugar colouring, well stirred together. Used as fraudulent substitutes for hops.

Quinine.—1½ oz. disulphate of quinine, ½ pint rectified spirit; digest with warmth, gradually dropping in a little dilute sulphuric acid (avoiding excess), and constantly agitating until the whole is dissolved. Every fl. dr. contains 8 gr. disulphate of quinine, or about 10 gr. of the neutral sulphate. If more sulphuric acid is added than suffices to dissolve the salt (*i.e.* convert it into a neutral sulphate), the solution is apt to deposit part of it on keeping, owing to the gradual formation of ether by the action of the excess acid on the alcohol.

Rennet.—For the preparation of concentrated solutions, only dried calves' stomachs are suitable, and those which have been blown out with air and dried as quickly as possible are best. The small stomachs of the youngest animals are richest in ferment. Fresh stomachs are useless for preparing a concentrated essence, as they yield a thick jelly which, by filtering, gives only a small quantity of liquid. Concentrated extract prepared from stomachs after 14 days is light yellow in colour, whilst that prepared after 6 to 8 months' storage of the stomachs is dark brown. This results from slight decay of the stomach, and as the colour does not affect the usefulness of the product, it is advisable to use stomachs which have been stored for at least 3 months. The portion of the stomach without folds, the *portio pylorica*, is cut away, as it is poor in ferment.

Acid liquids are usually employed for extracting, as they seem to produce richer solutions, but this is only because they act more quickly at first than water alone. Hydrochloric acid containing 0·1 and 0·2 per cent. of acid in 2 days gave extracts twice as rich in ferment as an aqueous one; but after 8 days all 3 solutions were equally strong. A little thymol was added to prevent decomposition during the experiment. When the temperature is raised to 86°–95° F. (30°–35° C.), water acts more rapidly than the acid, and the solution is richer than that produced by acid at the ordinary temperature.

Attempts were made to produce concentrated solutions by means of dilute acids, but without success. A 0·3 per cent. solution of salicylic acid gave a liquid which was quite fresh after 12 months, but after only 2 months its activity had fallen off to the extent of one-half.

A series of experiments made with solutions of common salt containing from 2 to 26 per cent. shows that solutions containing 3 to 6 per cent. of salt yield the liquids richest in ferment, and capable of the highest degree of concentration.

This property of dilute salt solutions depends on the fact, made known by Graham, that common salt is a very easily diffusible substance. Organic acids in combination with common salt are no better extraction agents than the salt alone; 5 per cent. solutions of sodium or potassium sulphate are less efficacious than the same strength of salt solution. Potassium chlorate behaves in much the same manner as common salt; an excess of the potassium chlorate, however, neither acts as efficiently as a precipitating agent nor as a preventive of decomposition.

60 to 80 grm. of calf's stomach, steeped for 5 days in 1 litre of a 5 per cent. solution of common salt at ordinary temperatures, yield a solution of which 1 vol. will coagulate 10,000 vols. of new milk at a temperature of 95° F. (35° C.) in 40 minutes. If the filtered solution is treated with 60 to 90 grm. more of stomach, a dilution of double strength is obtained; another repetition gives a solution 3 times the strength of the original.

To prevent decomposition, about 0·3 per cent. of thymol may be added to the concentrated rennet extract solution. Possibly a slight taste due to this may be detected in the finest cheese, but for the same reason oil of cloves is much more objectionable. Boric acid is on all accounts the best antiseptic to employ, and solutions to which it has been added may be kept in covered vessels for months.

All extract solutions lose strength on keeping; during the first 2 months the solution may become 30 per cent. weaker, then the strength remains nearly constant for 8 months in the case of a solution of 1 : 18,000. Alcohol is almost as good an antiseptic as boric acid, if the solution be preserved in well-stoppered flasks.

Detailed experiments show that the time required to coagulate milk is inversely proportional to the strength of the extract solution. From this the strength of a solution can be determined by adding 1 cc. to 1 litre of milk at 95° F. (35° C.), and noting the time required to coagulate the milk: this time multiplied by 10 gives the time for the proportion 1 : 10,000. (H. Sohxlet.)

Dr. J. Nessler has recently made some experiments with the object of comparing the activity of essence of rennet made according to Sohxlet's method from dried stomachs (as just described) and that of essence made from fresh stomachs. Experiments showed that, using corresponding quantities of dried and fresh stomach, the latter yielded the more active preparation. It was found, moreover, that the activity of the preparation from a fresh stomach could be increased by the removal of mucus, which not only made it more bulky, but prevented it from diffusing the milk so readily, and that this removal could be effected without injury by means of blotting-paper. Preparations made from the top layer of the inside of the stomach, scraped off with a knife, proved much more active than others for which the residue was used, but the residue contained too much ferment to permit it to be left unused. Nessler gives the following instructions for the preparation of an essence of rennet from fresh stomachs:—Chop up a fresh calf's stomach as finely as possible, pour upon it 2 litres water in which 101 grm. common salt have been dissolved, and shake well. After 12 hours, add 200 cc. of 90° alcohol, and allow the whole to stand, with frequent stirring, in a closed flask for 3 weeks, then decant, and add sufficient blotting-paper to cover it. After several weeks, during which the vessel must be kept well closed, the essence of rennet is drawn off into bottles and preserved. A liquor prepared in this way was, when fresh, capable of curdling 6000 times its volume of milk, and being kept in a well-corked bottle, it was found, after 2 years, to have diminished its activity only from 1 in 6000 to 1 in 5451. Nessler adds that distilled or rain water gives a more active essence than spring water, and that it is advantageous to mince the stomach as finely as possible. (*Pharm. Zeit.*)

Rhubarb.—5 oz. rhubarb powder, 5 oz. silicious sand, 1 pint proof spirit; extract by displacement.

Royale.—40 gr. ambergris, 20 gr. musk, 10 gr. civet, 10 gr carbonate of potash, 6 drops oil of cinnamon, 4 drops oil of rhodium, 4 drops otto of roses, ½ pint rectified spirit of wine; macerate 10 days or longer.

Sarsaparilla.—(1) 2¾ lb. sarsaparilla root (best red Jamaica) carefully decorticated, the bark reduced to coarse powder, and digested for 7 to 10 days in ¾ pint sherry and ¼ pint rectified spirit, with frequent agitation; the essence is expressed, and in a week the clear portion is decanted from the sediment.

(2) 7 oz. alcoholic extract of sarsaparilla, ¾ pint sherry; ¼ pint rectified spirit; dissolve and filter.

(3) 4 oz. alcohol extract, 1 pint sherry; dissolve, and filter.

(4) 4 oz. alcoholic extract, 1 lb. white wine.

(5) 10 oz. bruised sarsaparilla, 6 pints distilled water; macerate at a temperature of 120° F. (49° C.) for 6 hours, and strain; repeat with the same quantity of fresh water; mix the liquors, and evaporate in china vessels at 160° F. (71° C.)

(6) 2¾ lb. bark separated from sarsaparilla root, exhausted with water as (5);

the liquid is evaporated as quickly as possible in a water bath to 16 fl. oz., and when cold mixed with 4 fl. oz. rectified spirit.

(7) The infusion in No. (6) is evaporated to 10½ fl. oz., and when cold, mixed with ½ pint sherry; in a week, the clear portion is decanted from the sediment.

(8) Compound.—1 pint of (1), (2), (6), or (7) is triturated with the extract prepared from 3¼ oz. mezereon bark and 4 oz. extract of liquorice; when mixed, it is returned to the bottle, and 1½ fl. dr. essence of guaiacum and 20 drops oil of sassafras are added; the whole is well agitated for at least 15 minutes, and after a week's repose the clear portion is decanted as before.

(9) 8 oz. bruised sarsaparilla, q.s. hot water; exhaust the root by successive macerations, unite the liquors, and evaporate to 10 fl. oz.; strain, and add when cold 4 fl. dr. each alcohol (0·842) and tinctures of guaiacum and mezereon, 1 fl. oz. white wine, 12 drops oil of sassafras, 2 dr. extract of liquorice; agitate, and after repose decant as before.

Savoury Spices.—(1) 4 oz. black pepper, 3 dr. powdered turmeric, 1½ dr. coriander seeds (all ground), 1½ fl. dr. oil of pimento, ½ dr. each oils of nutmeg, cloves, cassia, and caraway, 1 pint rectified spirit; digest with agitation for a fortnight.

(2) 3 oz. black pepper, 1¼ oz. allspice, ½ oz. each nutmegs and burnt sugar, 1 dr. each cloves, cassia, coriander, and caraway seeds (all bruised or ground), 1 pint rectified spirit; digest with agitation for 14 days, press, and filter.

Soap.—4 oz. Castile soap (in shavings), 1 pint proof spirit; dissolve, and add a little perfume.

Soup Herbs.—1 oz. each lemon thyme, winter savory, sweet marjoram, and sweet basil, ½ oz. each eschalots and grated lemon-peel, ¼ oz. bruised celery seed, 1 pint proof spirit or brandy; digest for 10 to 14 days.

Spruce.—A decoction of the young tops of the black spruce fir, evaporated to the consistence of a thick syrup. Used to make spruce beer, &c.

Turtle.—3 oz. essence of anchovies, 3 oz. shallot wine, ½ pt. basil wine, ¼ pt. mushroom ketchup, juice of 2 lemons, yellow peel of 1 lemon, ½ oz. curry powder; digest for a week. Used to impart the flavour of turtle to soups and gravies.

Water Fennel. 1 oz. water fennel seed (fine-leaved water hemlock, bruised), 4 fl. oz. proof spirit; digest.

Westphalian.—(1) 1 pint crude or empyreumatic pyroligneous acid, 2 oz. sugar colouring; dissolve, and in a week decant the clear portion.

(2) 3 dr. tar, 2 oz. sugar colouring, 1 pint hot crude pyroligneous acid; agitate constantly for 1 hour, and after repose decant the clear portion.

(3) 1 pint acetic acid, 5 dr. creasote; mix.

(4) ¼ oz. Barbadoes tar, 1 oz. burnt sugar, 1 oz. common salt, ¾ pint strong pickling vinegar, ¼ pint port or elder wine; digest as before. Used to impart a smoky flavour to meat, fish, &c., by brushing over, or adding a little to the brine in which they are pickled.

Wormwood.—(1) 4 oz. extract of wormwood, 1 oz. oil of wormwood, 1 pint rectified spirit; digest a week, and filter.

(2) 1 pint tincture of wormwood, 5 dr. salt of wormwood, 1 dr. extract of wormwood; digest as before.

EXTRACTS are preparations of vegetable juices obtained by expression, decoction, or infusion, and evaporated down to a solid or semi-solid consistence. They are distinguished, according to their solvents, as aqueous or watery, alcoholic, spirituous (proof or u.p. spirit), acetic (dilute acidulated water), and ethereal. Fluid extracts are those evaporated only to a thin syrupy consistence, and mixed with ⅛ to 1/10 volume of rectified spirit. The terms simple and compound distinguish whether one or more substance has been extracted.

The process of preparing pharmaceutical extracts divides itself into two operations—obtaining a solution of the principle required, and evaporating that solution to a dense consistence. The first step is to reduce the solid substance to a state that will admit of its complete exhaustion by the solvent. This exhaustion is effected by digestion, displacement, decoction, or expression, and the resulting solution is carefully filtered.

The elimination of the excess water, in order to bring the solution to the desired consistence, is usually performed by evaporation. This may be conducted in an open shallow pan, in a water-bath, in a double-jacketed pan heated by steam, or in a vacuum-pan. The first method is objectionable from the danger of incineration; the second is good if ⅕ part of salt be added to the water in the bath, raising its boiling-point nearly 7° F., and thus ensuring an internal temperature of fully 212° F. (100° C.). Steam-jacketed pans are commonly used on the large scale; extracts prepared *in vacuo* are found to be much superior to the ordinary articles.

For several reasons, all these processes would seem to be inferior to that introduced by Prof. Herrara, whose observations satisfied him that, when the water partially congeals, the dissolved principles remain in solution in the mother liquors, and that 2 or 3 congelations are generally sufficient for obtaining the solutions concentrated enough to finish the extract by exposure upon plates to the heat of the sun, or in a drying-closet heated to 86° F. (30° C.). Extracts prepared by this method accurately represent the properties of the plants, and those principles which are changed or volatilized by the influence of heat remain unaffected. The apparatus required is very simple, being mainly a modification of the *sorbetière*, or ice-cream freezer. The freezing mixture may be ice and salt, or ice and calcium chloride. As the congelation progresses, the ice-cake is removed, broken up, and pressed, to separate the mother-liquor as completely as possible, which is finished by evaporation in shallow dishes.

Extracts should be preserved out of contact with the air as soon as they are prepared. When in pots, the inner surface of the bladder used to tie them down should be moistened with a few drops of oil of cloves or creosote. Hard extracts may be kept in gut-bladders, covered over in stone pots. The essential qualities of a good extract are:—(1) Freedom from grit, and complete solubility in 30 parts of the solvent used in its preparation, forming an almost clear solution; (2) proper consistence, and uniform colour and texture. Extracts should be rejected as worthless when over 6 months old. The following are some of the chief kinds.

Aconite.—(1) Bruise 112 lb. fresh leaves and flowering tops, press out the juice, heat it gradually to 130° F. (54½° C.), and separate the green matter by a calico filter. Heat the strained liquor to 200° F. (93½° C.), to coagulate albumen, and again filter. Evaporate the filtrate by a water bath to the consistence of a thin syrup; add the green colouring matter previously separated, and, stirring the whole together assiduously, evaporate at a temperature not exceeding 140° F. (60° C.) to a pill consistence.

(2) Bruise in a mortar 1 lb. fresh leaves of aconite, express the juice, and evaporate it, unstrained, to a proper consistence.

(3) Beat the fresh leaves of aconite to a pulp, and express the juice; subject the residue to percolation with rectified spirit until the latter passes through without being materially coloured; unite the expressed juice and the percolated tincture, filter, distil off the spirit, and evaporate in a vapour or a water bath to a proper consistence.

(4) *Alcoholic.*—1 lb. aconite in coarse powder, 2½ pints proof spirit; proceed by displacement, and when all the spirit has penetrated the powdered mass, keep this covered with distilled water, until the liquid begins to cause a precipitate in falling into that which has previously passed through; next distil the spirit from the tincture, and evaporate the residue to the proper consistence.

(5) 1 lb. aconite; 1 qt. or q.s. spirit, sp. gr. ·935 (= 13 u.p.); as last.

(6) From the tincture prepared with

rectified spirit, and by either maceration or displacement.

(7) The juice is expressed from the fresh herb, which is then sprinkled with about $\frac{1}{3}$ of its weight of water, and again pressed; the mixed and strained liquid is evaporated in a vapour-bath at 122° to 140° F. (50°–60° C.), to about $\frac{1}{2}$; to this, as soon as cold, an equal weight of spirit (sp. gr. ·900) is added; and after frequent agitation for 24 hours, the whole is filtered, with pressure; the marc is treated with fresh spirit (equal to about $\frac{1}{4}$ that first used) and again pressed; the mixed liquors are filtered and evaporated, as before, to the proper consistence.

(8) *Ammoniated.*—1 dr. extract of aconite, 10 or 12 drops strongest liquor of ammonia; mix.

(9) *Dried.*—The expressed juice, strained through a sieve or coarse linen, is at once exposed in earthen dishes, in layers of about 2 lines deep, in a stove or current of dry air, to a temperature ranging between 95° and 104° F. (35°–40° C.), until reduced to dryness. The dried extract is packed in bottles.

(10) *Root.*—From a tincture of the root, made with rectified spirit. It is said to be 12 times as strong as the extract of the leaves.

(11) *Saccharated.*—4 oz. extract of aconite, 1 oz. sugar of milk in powder; mix; dry the mass in a warm place, adding sugar of milk q.s. to make the whole equal in weight that of the extract used (4 oz.).

Aloes.—(1) 1 lb. Barbadoes aloes in small pieces, treated with 1 gal. boiling water for 12 hours, and the clear liquid evaporated.

(2) 1 lb. Socotrine aloes treated with 1 gal. boiling water for 12 hours, and the clear liquid evaporated to dryness.

(3) 4 oz. aloes (hepatic), 1 qt. water; boil till dissolved; when cold, decant the clear liquid and evaporate as before.

(4) Macerate powdered aloes in cold water for 48 hours, with frequent agitation, and then evaporate in a water bath at a temperature not exceeding 150° to 165° F. (65½° to 74° C.), until a pilular consistence is obtained.

(5) Dissolve 8 oz. extract of aloes in 32 oz. distilled water; gradually add 1 oz. sulphuric acid, and evaporate to a dry extract.

Angelica.—(1) 2 oz. angelica root, 2½ oz. rectified spirit, 9 oz. water; digest, strain, and evaporate.

(2) 2 lb. angelica root, 1 gal. rectified spirit; make a tincture; to the marc add 1 gal. proof spirit, and repeat the digestion; filter the two tinctures separately, mix, distil off the spirit, and evaporate.

Apples.—Peel and reduce to pulp, 6 lb. unripe crab-apples; add 1 lb. iron wire in small coils; digest in a vapour bath for about a week, express, strain, decant, and evaporate in a porcelain vessel, with constant stirring, to the consistence of a soft extract; dissolve the residue in 4 parts water, strain, and evaporate as before.

(2) Reduce 5 lb. unripe apples to a pulp, mix with cut straw, and press; add 1½ oz. reduced iron to the strained juice after removal of the sediment; when this has dissolved, add as much water to the cooled liquid as will make up 4¾ lb.; filter, and reduce to a thick extract.

Belladonna.—(1) Bruise 112 lb. fresh leaves and tender branches in a stone mortar, and press out the juice; proceed as in Aconite (1).

(2) Express the juice from the bruised fresh plant, sprinkle the marc with water, and again apply pressure; mix the expressed liquids, filter and evaporate the filtered liquor in a vapour bath to the consistence of an extract.

(3) The leaves are collected when the plant begins to flower. The expressed juice is allowed to stand for 24 hours, and the clear portion is decanted; the sediment is placed on a calico filter, washed with an equal bulk of cold water, and the filtrate mixed with expressed juice; the mixed liquid is heated in a water bath to coagulate its albumen, and after being skimmed and filtered through flannel whilst hot, the washed sediment is added, and the whole evaporated as before.

(4) The expressed juice is heated

to the boiling point, filtered, and evaporated.

(5) The expressed juice is coagulated by heat cautiously applied, and filtered; the filtrate is reduced to the consistency of a syrup, and mixed with an equal volume of nearly anhydrous alcohol (say 90 per cent.); the clear portion is lastly evaporated as before.

Buchu. — (1) *Ethereo-alcoholic.* — 1 lb. buchu in coarse powder, 4 fl. oz. ether, 12 fl. oz. rectified spirit; percolate without digestion, adding dilute alcohol until a pint of ethereo-alcoholic tincture is obtained; suffer this to evaporate spontaneously; treat the residue in the displacer with dilute alcohol till 2 pints are obtained; evaporate to a syrup, add the product of the first tincture, mix, and complete the evaporation.

(2) 8 oz. buchu leaves, 16 fl. oz. rectified spirit, for a tincture by displacement, adding water until 12 fl. oz. have passed through; allow this to evaporate spontaneously until reduced to ½; next digest the mass in the percolator with 1 pint cold water for 12 hours; express a pint, and evaporate this to 10 fl. oz. of residual tincture; agitate together, and in a few days filter, or decant the clear portion.

Cainca.—Put 10 oz. dried cainca root into a percolator, pour on it enough proof spirit to penetrate the powder in every part, and let it remain 12 hours; allow the liquid to drain, and pass successively through the powder in the percolator as much proof spirit as will amount with that previously used to 6 oz.; distil off the spirit, and evaporate to a soft extract.

Calabar Bean. — 1 oz. Calabar bean in coarse powder, 5 oz. rectified spirit; macerate the bean for 48 hours in ¼ of the spirit in a closed vessel, agitating occasionally; transfer to a percolator, and when the fluid ceases to pass, add the remainder of the spirit, so that it may slowly penetrate through the powder; subject the residue of the bean to pressure, adding the pressed liquid to the product of the percolation; distil off the spirit, and evaporate what is left to the consistence of a soft extract by a water bath.

Calumba. — 1 oz. calumba cut small, 5 oz. water; macerate in ½ the water for 12 hours, strain, and press; macerate again with the remaining water, strain, and press; mix and filter the liquor, and evaporate with the heat of a water bath to pill consistency.

Cherry, Wild.—*Fluid.*—16 oz. wild cherry in fine powder, 4 oz. glycerine, 8 oz. water; mix the glycerine and the water, and digest the wild cherry in 8 oz. of the mixture for 4 days; pack in a percolator, and pour on the remaining 4 oz. glycerine and water; when this has disappeared from the surface, pour on rectified spirit (·817) until 12 oz. of fluid have been obtained, and set this portion aside. Then percolate with spirit until 20 oz. more have been obtained; evaporate to 4 oz., and mix with the reserved portion.

Cinchona.—(1) 16 oz. yellow cinchona bark in coarse powder, sufficient distilled water, 1 oz. rectified spirit; macerate the bark in 40 oz. water for 24 hours, pack in a percolator, and add water until 240 oz. have passed through, or until the bark is exhausted; evaporate the liquor to 20 oz. at a temperature not exceeding 160° F. (71° C.); filter, and continue the evaporation to 3 oz., or until the sp. gr. of the liquid is 1·200; when cold, add the spirit gradually, constantly stirring.

(2) 3 lb. coarsely-bruised yellow cinchona; 4 pints temperate distilled water; macerate for 24 hours, constantly stirring, and strain through linen; what remains, again macerate in 1 qt. water for 24 hours, and strain; evaporate the mixed liquids to a proper consistence.

(3) *Resinous.*—(*a*) 4 oz. any variety of cinchona bark in powder, 24 fl. oz. proof spirit; prepare a tincture by displacement; distil off most of the spirit, and evaporate the residue to the consistence of an extract.

(*b*) 1 lb. Peruvian bark, 4 pints rectified spirit; make 4 pints of tincture by displacement; add water to the mass in the percolator; digest, and obtain 6 pints of infusion; distil off the spirit from the tincture, and evaporate the infusion to the consistence of syrup, then mix the two, and complete the evaporation.

(c) 2 lb. yellow bark, 4 fl. dr. hydrochloric acid, 1 gal. water; boil, strain, and repeat the decoction with fresh water and acid; mix the decoctions, filter, and agitate with 2½ oz. fresh slaked lime; filter or decant, dry the residue, and exhaust with q.s. hot alcohol; evaporate the alcoholic tincture to a pilular consistence.

(4) 1 oz. Peruvian bark in powder, 8 oz. white wine (sherry); digest 3 days, express, filter, and evaporate.

Colchicum.—*Acetic.*—(a) 19 oz. crushed fresh corms, previously peeled, 1 oz. acetic acid; stir together, press, boil, strain through flannel, and evaporate to a soft extract.

(b) 14 lb. dried corms, 6 pints acetic acid (pyroligneous), 5¼ gal. distilled water; digest for 14 days, express, filter, and evaporate.

Colocynth.—(1) Colocynth pulp, cut in pieces and the seeds removed, simply macerated in cold water for 36 hours, frequently pressing it with the hands, and afterwards strongly pressing out the liquor, which must be strained before evaporating.

(2) *Compound.*—(a) 6 oz. colocynth free from seeds, 12 oz. extract of Socotrine aloes, 4 oz. scammony or resin of scammony in powder, 3 oz. hard soap in powder, 1 oz. cardamoms free from capsules in fine powder, 160 oz. proof spirit; macerate the colocynth in the spirit for 4 days, press out the tincture, distil off the spirit, and add to it the extract of aloes, soap, and scammony; evaporate the residue by a water bath to a pilular consistence, adding the cardamoms towards the end of the process.

(b) 6 oz. colocynth pulp, sliced, without the seeds, 1 gal. proof spirit; digest with a gentle heat for 4 days, express, strain, and add 12 oz. extract of aloes, 4 oz. powdered scammony, 3 oz. Castile soap cut small; distil and evaporate to a proper consistence, adding towards the last, 1 oz. powdered cardamoms.

(c) 18 lb. Turkey colocynth boiled in about 20 times its weight of water for 5 or 6 hours; to the strained decoction add 40 lb. hepatic aloes, which are boiled until dissolved, when the solution is decanted. In the meantime the colocynth is exhausted with a second quantity of water (less than the first), and the strained liquor is added to the undissolved residue of the aloes, and boiled for a few minutes; after which it is drawn off and mixed with the first decoction of aloes; the mixed liquors are allowed to stand until quite cold (say next day), to deposit the resinous portion. The liquor is decanted or drawn off, and set evaporating as quickly as possible; as soon as a treacly consistence is arrived at, the whole is allowed to cool considerably, and 4 lb. clean moist sugar and 10 lb. Castile soap (previously melted with a little water) are added; 6 lb. powdered scammony is next gradually sifted in, the extract all the time being assiduously stirred by a second person. Lastly, the heat is further moderated, and the stirring continued until a rather harder consistence is acquired than is proper for the extract, when the steam is wholly shut off, or the vessel removed from the heat. As soon as the whole has become sufficiently cool to prevent any considerable evaporation of the spirit, 1 qt. essence of cardamoms is expertly stirred in, and the extract at once (whilst still warm) put into stone jars or pots, and tied or covered over.

(d) 2¼ lb. Turkey colocynth, 5½ lb. hepatic aloes, 1½ lb. powdered scammony, 6 oz. cardamoms (or ½ pint essence), 1 lb. 2 oz. genuine Castile soap, ½ lb. pale moist sugar; proceed as last.

Cotton Root.—16 oz. cotton root in very fine powder macerated with 3 fl. oz. glycerine, 8 oz. rectified spirit, 5 oz. water in closed percolator for 4 days; let the percolation commence, and finish it by adding dilute alcohol (eq. vols. ·835 alcohol and water) until 24 oz. have been obtained; reserve the first 14 oz., and evaporate the remaining 10 oz., to which previously add 1 fl. oz. glycerine to 2 fl. oz., and mix with the reserved portion.

Cubebs.—*Fluid.*—(1) 1¼ lb. cubebs ground in a coffee-mill, 1 qt. rectified spirit; prepare a tincture, either by displacement or by digestion for a week, and reduce it by distillation, at a very gentle heat, until the whole measures exactly 1 pint.

(2) Nearly 1 lb. cubebs, q.s. ether; make 1 qt. of tincture; distil off 1½ pint of the ether by the heat of a water bath, and expose the residue in a shallow vessel until the remainder of the ether has evaporated.

(3) 16 oz. cubebs in a moderately fine powder, 16 oz. alcohol (·817); macerate in a closed percolator for 4 days, let the percolation commence, and finish it by adding more menstruum until 24 oz. have been obtained; reserve the first 14 oz., evaporate the remaining 10 oz. to 2 oz., and mix this with the reserved portion.

Ergot.—16 oz. ergot in coarse powder, 20 oz. ether, 70 oz. distilled water, 8 oz. rectified spirit. Shake the ether in a bottle with half its bulk of the water, and after separation decant the ether. Place the ergot in a percolator, and free it from oil by passing the washed ether through it; remove the marc and digest it in the remainder of the water for 12 hours at 160° F. (71° C.). Press out the liquor and evaporate it to 9 oz., and when cold add the 8 oz. spirit; allow it to stand for an hour to coagulate; filter, and make up the quantity to 16 oz.

Gentian.—3 lb. sliced gentian root, 4 pints temperate distilled water; macerate for 12 hours, and gently express the liquor; repeat the maceration with 1 qt. water for 6 hours, and evaporate the mixed liquors.

Golden Seal.—*Fluid.*—16 oz. hydrastis (golden seal) in very fine powder; macerate with 2 oz. glycerine, 14 oz. rectified spirit, in closed percolator for 4 days; let the percolation commence, and finish by adding a mixture consisting of 2 parts spirit and 1 of water, until 24 oz. have been obtained. Remove the first 14 oz., evaporate the remaining 10 oz. to 2 oz., and mix with the reserved portion.

Hellebore.—2 lb. powdered black hellebore, ½ lb. salt of tartar, 7 pints dilute alcohol (sp. gr. ·935); digest 12 hours, and express the tincture; add to the marc 7 pints white wine; digest for 24 hours, express, mix the tincture, filter, and evaporate.

Hops.—(1) 8 oz. hop, 15 oz. rectified spirit, 80 oz. distilled water; macerate the hop in the spirit for 7 days, press out the tincture, filter, and distil off the spirit, leaving a soft extract; boil the residual hop with the water for 1 hour, express the liquor, strain, and evaporate on a water bath to the consistence of a soft extract. Mix the 2 extracts, and evaporate at a temperature not exceeding 160° F. (71° C.) to a pilular consistence.

(2) 2½ lb. commercial hops, 2 gal. boiling distilled water; macerate for 24 hours, boil to 1 gal., strain whilst hot, and evaporate to a proper consistence.

Jaborandi.—*Fluid.*—16 oz. jaborandi leaves in moderately fine powder, sufficient of alcohol (50 per cent.); moisten the powder thoroughly with the menstruum, pack in a conical glass percolator, place a layer of 2 in. well-washed sand on the top of the cloth covering the material, add menstruum until the liquid begins to drop from the percolator; then close the lower orifice with a cork, and securely cover the percolator; set aside in a moderately warm place for 4 days. At the expiration of this time, remove the cork, and add more menstruum by degrees until the material is exhausted. The first 14 oz. of the percolate are reserved, and the remainder evaporated in a water bath, with constant stirring towards the close, to 2 fl. oz., and added to the reserved portion. If the percolation and evaporation have been properly performed, the fluid extract will not require to be filtered.

Jalap.—(1) 1 oz. jalap in coarse powder, 5 oz. rectified spirit, 10 oz. distilled water; macerate the jalap in the spirit for 7 days, press out the tincture, filter, and distil off the spirit, leaving a soft extract; again macerate the residual jalap in the water for 4 hours, express, strain through flannel, and evaporate by a water bath to a soft extract; mix the two extracts, and evaporate at a temperature not above 140° F. (60° C.) to pillular consistence.

(2) 2½ lb. powdered jalap; 1 gal. rectified spirit; digest 4 days, and express the tincture; boil the marc in 2 gal. water until reduced to ½ gal.; filter the tincture and decoction separately, and let one distil and the other evaporate until each thickens; mix the two, and complete the evaporation.

Juniper.—Macerate juniper berries in water at 77° to 86° [illegible] C.) for 24 hours; strain, repeat the process with a fresh quantity of water, mix the liquors, filter, and evaporate.

Lactucarium.—A difficulty is usually met with in making the lactucarium preparations, occasioned by the caoutchouc principle always present in this as well as most, if not all, the products from the lactescent plants; in order to overcome this difficulty, petroleum benzine has been found the most practical, being efficient and cheaper than most of the solvents for caoutchouc. It was found that by beating the lactucarium in an iron mortar until it is well crushed, it separates into layers, or plates, or very coarse granulation (according to its degree of dryness), as the nearest possible approach to comminution, it being impossible to powder it without the addition of sand or other foreign substance. Thus treated and macerated with benzine, the caoutchouc principle is readily dissolved, and the lactucarium is fitted for treatment with other menstruum. After numerous experiments, the following is offered as a practical working formula for the fluid extract:—Take lactucarium, 16 troy oz.; deodorized petroleum benzine, 32 fl. oz.; a sufficient quantity of diluted alcohol. Beat the lactucarium thoroughly in an iron mortar; introduce it into a wide-mouth bottle of about 3 pints capacity, adding the benzine, corking tight, and allowing it to macerate, with frequent agitation, for 24 hours; let it rest about 24 hours, or until the lactucarium subsides, and the benzine solution becomes clear or nearly so; having decanted the benzine solution, transfer the lactucarium to a stone or glass slab or other similar vessel, spreading it as thin as possible, allowing it to remain in this situation until completely dry (at least 24 hours); rub it up in an iron mortar with an equal bulk of clean sand; introduce it into a cylindrical percolator, first prepared with a disc of flannel and a thin layer of sand, pack lightly, and add sufficient diluted alcohol to cover several inches, and after closing the outlet with a cork or otherwise, allow it to macerate 24 hours; percolate to exhaustion, reserving the first 4 fl. oz. By means of a still, reclaim the alcohol, and evaporate the residue in a water bath to 10 fl. oz., mixing this with the reserved percolate, and filter, adding sufficient diluted alcohol to wash the filter and remaining residue, until the product weighs 16 troy oz. (Lemberger).

Lettuce.—The external parts of the stalks and the old and yellow leaves, after the plants have flowered, are macerated in water for 24 hours, and decocted for 2 hours; the expressed liquid is first evaporated by a gentle heat, and afterwards spread on shallow dishes, and dried by exposure to a current of air.

Lobelia.—8 oz. bruised lobelia seeds, 4 pints dilute alcohol (sp. gr. ·935), 1 fl. oz. acetic acid; macerate for 24 hours, and subsequently displace.

Logwood.—1 oz. logwood in chips, 10 oz. boiling distilled water; macerate 24 hours, boil to 5, strain, and evaporate to an extract, but not in iron vessels.

Madder.—1 oz. tincture of dyers' madder made with rectified spirit, and 3 oz. water.

Male Fern.—1 oz. fern root in coarse powder, 2½ oz. ether (or a sufficiency); pack closely in a percolator with 1 oz. of the ether, add the rest at intervals until it passes through colourless; distil off the ether, and the liquid extract remains.

Malt.—Extract of malt represents the matter dissolved from malted cereals, generally malted barley, by water. It is met with in trade in three forms;

the first, as a more or less viscid extract, containing 20 to 35 per cent. of water. The colour varies much—in accordance with the temperature at which it has been evaporated and the colour of the malt used—from a golden yellow to a deep brown. The second form is that of a thin solution, containing 60 to 80 per cent. of water. The third form differs from the second in containing 3 to 4 per cent. of alcohol, apparently the result of fermentation. Amongst the various brands, the first form is the most commonly met with. The matter dissolved from malted barley by water consists of albumenoids, phosphates, maltose, dextrine, and a peculiar principle termed diastase. Extract of malt may be considered both as a remedy and as a food. In disease, where artificial digestion is desired, it appears to have a very important application, quite analogous to the application of pepsine to the artificial digestion of albumenoids. Extract of malt is commended as a sort of *elixir vitæ*, but probably its value depends almost entirely upon the amount of diastase which it contains.

Without going fully into the question of the manufacture of malt extract, a few remarks upon it may not be out of place. Diastase is said, when heated in aqueous solution to a temperature of 155° to 158° F. (68° to 70° C.), to lose its power of converting starch. This temperature, then, ought not to be exceeded in manufacturing the extract; indeed, a lower temperature than this should be observed, to prevent the coagulation of albumenoids, thereby rendering them insoluble. It is, however, almost impossible to evaporate at so low a temperature without the use of costly vacuum apparatus, and hence it might be expected that malt extract made by pharmacists without such apparatus would contain little, if any, diastase. The method of the German pharmacopœia, which is largely followed, directs digestion of the malt with water—first, in the cold, then at 150° F. (65½° C.), and the solution thus obtained filtered and evaporated at 212° F. (100° C.). Of course no diastase survives this evaporation. Another method is to heat the malt with water at 150° F. (65½° C.), until no starch remains, filter and evaporate at 212° F. (100° C.). This method differs from that of the German pharmacopœia, inasmuch as part of the diastase is used up in converting the starch of the malt, and the remainder only is destroyed by the evaporation. From malt extract made by both these methods no diastase resulted in either case. Extract made by macerating the malt in cold water, straining, and evaporating under a low atmospheric pressure at a temperature not exceeding 155° F. (68° C.), was found to be rich in diastase. Such a process as this is recommended by the Pharmaceutical Society of Paris.

The following table includes the results of the examination of a number of trade samples of extract of malt. The albumenoids were calculated from the results of nitrogen combustions in the usual manner. Phosphates were determined in the ash as pyrophosphate of magnesium. The maltose was estimated by a standard solution of cupro-potassium tartrate. The dextrine was estimated by boiling a solution of the malt extract with dilute sulphuric acid, and estimating the sugar present by the cupro-potassium solution as glucose—for maltose and dextrine are both convertible into glucose by ebullition with dilute sulphuric acid—calculating the glucose into maltose, then subtracting from the whole the amount of maltose found before boiling with dilute acid, and calculating the remainder into dextrine. Large quantities of diastase, and therefore large quantities of malt extract, are necessary to effect the entire conversion of every trace of starch, whereas, as is well known, very small quantities of diastase, and therefore very small quantities of malt extract, will convert relatively large quantities of starch into a liquid condition; that is, will practically digest large quantities of starchy foods. Such a result, useful enough for purposes of digestion, but not sufficiently sharp for analytical purposes, is obtained by using the "pudding" process.

RESULTS OF EXAMINATION OF TRADE SAMPLES OF MALT EXTRACT. (Dunstan and Dimmock).

Constituents.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
Water at 212° F. (100 C.)	61·3	67·6	32·0	27·0	19·6	20·0	19·4	31·9	24·2	19·0	84·5	30·2	86·3	20·0
Ash	1·0	1·2	1·2	1·2	1·4	1·6	1·4	1·1	1·6	1·1	0·4	1·1	0·3	1·5
Maltose	26·3	16·9	41·8	53·0	67·0	48·7	50·0	53·8	59·0	28·9	4·6	11·4	4·6	50·4
Dextrine	2·5	3·9	5·2	9·8	5·1	6·2	9·1	9·5	9·0	7·2	3·1	5·7	3·1	8·5
Albumenoids	6·3	6·2	6·1	6·3	7·7	5·9	8·2	6·3	6·2	6·3	4·6	4·0	0·5	5·0
Phosphates as phosphoric pentoxide	0·3	0·3	0·3	0·4	0·5	0·2	0·5	0·2	0·3	..	0·1	0·3	·06	0·5
Grammes of extract required to convert one gramme starch	..	..	..	..	17·3	..	..	..	29·0	..	..	..	..	34·0
Alcohol	..	..	..	..	..	..	..	..	..	..	..	..	4·1	..

There are great difficulties in the way of manufacturing a good malt extract, and when it is attempted to overcome one difficulty another is introduced. What is required is a malt extract which shall not only be rich in diastase, but also contain a fair proportion of albumenoids in a coagulable condition, or one which is readily assimilable by the system. It ought also to contain a fair amount of maltose, and a relatively small amount of dextrine, and thus the matter becomes one of very great difficulty as regards the best mode of operating. A malt extract rich in diastase may be obtained by using a larger proportion of water with an initial temperature of 140° F. (60° C.), and then raising the temperature to a little over 150° F. (66° C.) towards the end of the mashing process. But this method, in which a relatively large amount of water is used, is very likely to effect an alteration in the albumenoids. At all events, acetification will readily set in, and there is great danger of effecting a change during the evaporation process. Again, with reference to the use of water, it is preferable to begin with a low temperature rather than a high one, because the malt partly agglomerates and cannot be so readily mixed with the water at the higher temperature. (Naylor.)

The following recipes are published:—

(1) An infusion of malt is made in water at 160° to 170° F. (71° to 77° C.), drained off without pressure, and evaporated to a honey-like consistence. The quantities are—1 pint crushed malt in 3 pints hot water, and the infusion occupies about 4 hours.

(2) 47½ oz. extract of malt, mixed with 1 oz. iron pyrophosphate and ammonia citrate dissolved in 1½ oz. water.

(3) 6 oz. coltsfoot leaves, 6 oz. spotted lungwort, 8 oz. liquorice, 2 lb. stoned raisins, 6 gal. old strong ale, not "hopped"; boil down to 4 gal., express strongly, and evaporate to honey-like consistence.

Meat.—1 oz. lean meat, recently killed, chopped very small; 8 oz. cold water; shake well together for 10 minutes; heat gradually to boiling; let simmer gently for a few minutes; strain through a hair-sieve whilst still hot; evaporate to a soft mass. 1 lb. meat yields barely 1 oz. (Liebig.)

Mezereon. — (1) 1 lb. mezereon bark cut small, 8 pints rectified spirit, 1 pint ether; macerate the mezereon in 6 pints of the spirit for 3 days, with frequent agitation; strain and press; add the remainder of the spirit to the residue of the mezereon, and again macerate for 3 days with constant agitation; strain and press. Mix and filter the strained liquors, recover the greater part of the spirit by distillation, evaporate what remains to the consistence of a soft extract, put this in a stoppered bottle with the ether, and macerate for 24 hours, shaking frequently; decant the ethereal solution, recover part of the ether by distillation, and evaporate what remains to the consistence of a soft extract.

(2) 10 oz. mezereon in moderately coarse powder, 16 oz. alcohol (·817); proceed as for fluid extract of cubebs.

Myrrh.—Compound. 2 oz. myrrh, 2 dr. gum-arabic powder; triturate, add water enough to form a thick emulsion, and 4 oz. extract of couch-grass.

Narcotic.—Dissolve 6 oz. alcoholic extract of the plant in 14 dr. or 2 oz. strong alcohol by trituration in a porcelain mortar; mix with it 30 oz. powdered white sugar, gradually added, with constant stirring; set the mixture in a warm situation until dry; add enough sugar to make up 36 oz.

Nux Vomica. — *Alcoholic.* — (1) Soften nux vomica by steam, dry rapidly, and reduce to fine powder; boil with rectified spirit until exhausted; strain, distil off the spirit, and evaporate to the consistence of a soft extract.

(2) 8 oz. nux vomica seeds, 3 pints rectified spirit; expose the seeds to steam until softened, then bruise, slice, dry, and macerate them in ⅘ of the spirit for 7 days; express the tincture, and repeat the maceration with the remaining ⅕ of the spirit; again express the liquid; filter the mixed tinctures, distil off the greater part of the spirit, and complete the evaporation by a gentle heat.

Opium.—(1) 1 lb. opium in thin slices, 6 pints distilled water; macerate the opium in 2 pints of the water for 24 hours; express the liquor. Reduce the residual opium to a uniform pulp, macerate again in 2 pints of the water for 24 hours; express; repeat the operation a third time; mix the liquors, strain through flannel, and evaporate by a water bath to pilular consistence.

(2) 1½ lb. powdered opium, 2½ pints cold distilled water; mix gradually; macerate for 24 hours, frequently stirring with a spatula; press, strain, and repeat the maceration for 24 hours with a fresh 2½ pints water; evaporate the mixed strained liquors to a proper consistence.

(3) 16 oz. distilled water, 4 oz. rectified spirit; digest the extract of opium in the water for an hour, stirring frequently; filter; add the spirit.

(4) 1 oz. opium, 1 qt. distilled vinegar; digest 2 days with heat; decant, filter, evaporate.

(5) 4 oz. aqueous extract, 1 oz. resin; beat well together; add 16 oz. boiling water; boil to ½; add 8 oz. cold water, filter, evaporate.

(6) 4 oz. opium, 4 oz. sugar, 1 qt. water; rub together, and keep the mixture loosely covered in a warm situation, about 70° F. (21° C.), for 10 days or more; add 1 qt. cold water; next day filter, and evaporate.

(7) 1 oz. unstrained mixture of opium, 8 oz. water, and a little yeast; leave for a week at a temperature of 68° to 77° F. (20° to 25° C.); dilute, filter, and evaporate.

Pareira.—(1) 1 oz. pareira root in coarse powder, 10 oz. boiling distilled water; digest the pareira with 1½ oz. water for 24 hours; pack in a percolator, and water till by slow percolation 10 oz. has passed through; evaporate in a water bath to a pilular consistence.

(2) 16 oz. pareira in coarse powder, 160 oz. boiling distilled water, 3 oz. rectified spirit; macerate in 20 oz. water for 24 hours; pack in a percolator, adding more of the water; allow

the liquor slowly to pass until 160 oz. have been collected, or the pareira is exhausted; evaporate to 13 oz.; when cold, add the spirit; filter, and make up to 16 oz.

Pellitory.—1 pint rectified spirit, ½ pint ether; mix; pour gradually on 1 lb. pellitory root in a percolator; afterwards pour on 1 pint alcohol, and subsequently sufficient proof spirit to displace 2½ pints tincture; the latter is either suffered to evaporate spontaneously or by a very gentle heat until a soft extract is obtained.

Pinkroot.—(1) *Compound.*—4 oz. bruised Carolina pinkroot, 3 oz. senna, 1 dr. savine: pour on 1 qt. boiling water; when cold, add ½ pint rectified spirit; digest 24 hours, express (or percolate), filter, evaporate to 12 fl. oz., in which dissolve 1 oz. manna, 8 oz. sugar.

(2) *Fluid.*—1 lb. pinkroot, 3 pints proof spirit; make a tincture, evaporate to 10 fl. oz., add ¾ lb. sugar and enough rectified spirit to make exactly a pint.

(3) 16 oz. pinkroot, 8 oz. senna (both in coarse powder), 2 pints dilute alcohol (sp. gr. ·935); macerate for 2 days; proceed by displacement, adding fresh spirit, until 4 pints have passed through; filter; evaporate to 20 fl. oz.; add 1 oz. carbonate of potash, ½ dr. oil of caraway, ½ dr. oil of aniseed, (previously triturated with) 24 oz. powdered sugar; apply a gentle heat to dissolve the sugar.

Poppies. — (1) 16 oz. capsules coarsely powdered, 2 oz. rectified spirit, sufficient distilled water; mix the capsules with 40 oz. of the water, stirring frequently for 24 hours; pack in a percolator; pass water slowly through until about 160 oz. have passed; evaporate by a water bath to 20 oz.; when cold add the spirit; after 24 hours, filter, and evaporate to a pilular consistence.

(2) 15 oz. bruised poppy-heads without the seeds, 1 gal. boiled distilled water; macerate 24 hours, boil to ½, strain, and complete the evaporation.

Quassia.—1 lb. scraped quassia, sufficient distilled water; macerate the quassia in 8 oz. of water for 12 hours; pack in a percolator; add water till the quassia is exhausted; evaporate, filter before it becomes thick, and again evaporate in a water bath to a proper consistence for pills.

Rhatany.—1 oz. rhatany in coarse powder, 15 oz. cold distilled water; macerate 24 hours in 2 oz. of the water; percolate the whole; evaporate by water bath to dryness.

Rhubarb. —(1) 8 oz. sliced or bruised rhubarb, 5 oz. rectified spirit, 50 oz. distilled water; macerate 4 days; strain, and set to subside; decant the clear, strain, mix, and evaporate to a proper consistence over a water bath at 160° F. (71° C.).

(2) *Compound.* — 3 dr. extract of rhubarb, 1 dr. extract of aloes, softened with 4 dr. water; evaporate to an extract; dry in a warm place, and powder.

(3) *Fluid.*—Mix 8 oz. rhubarb in coarse powder, with bulk coarse sand, and moisten with dilute alcohol (sp. gr. ·935 = 13 u.p.) to form a pasty mass; in a short time introduce it into a percolator, shake until uniformly settled, cover with cloth or paper; pour on the rest of the spirit (the remainder of 2 pints) until the product has little odour or flavour of the root; gently evaporate the tincture to 5½ fl. oz., and add 5 oz. sugar, when the whole should measure 8 fl. oz.

Sarsaparilla.—(1) *Alcoholic.*—(*a*) 16 oz. bruised sarsaparilla, 2 oz. bruised liquorice root, 2 oz. rasped guaiacum wood, 2 oz. sliced sassafras bark, 6 dr. sliced mezereon, 7 pints spirit (sp. gr. ·935 = 13 u.p.); digest 14 days, express, filter, evaporate to 12 fl. oz., add 8 oz. sugar; as soon as this is dissolved, withdraw the heat.

(*b*) 16 oz. sarsaparilla, 2 oz. liquorice root, 2 oz. sassafras, 360 gr. mezereon, all in fine powder; 4 oz. glycerine, 8 oz. rectified spirit, 4 oz. water; macerate in a closed percolator for 4 days; let the percolation commence, and finish it by adding diluted alcohol (equal volumes of alcohol at ·835 and water) until 2 pints have been obtained. Reserve the first 12 oz., having added 4 oz.

glycerine to the remainder of the percolate, which evaporate to 6 oz., and mix with the reserved portion.

(2) *Compound.*—30 lb. coarse guaiacum shavings, 24 lb. Italian juice, 6 lb. mezereon root, boiled with sufficient water for 1 hour; the decoction is drawn off, and the boiling repeated with fresh water 2nd and 3rd time; the mixed decoctions are allowed to deposit for 6 or 8 hours, and the clear portion decanted and strained through flannel; the liquid is now reduced to the consistence of treacle; 9 lb. extract of sarsaparilla is added, and the evaporation conducted at a considerably lower temperature until near its completion, when the remaining evaporation is conducted at the expense of the heat retained by the metal of the pan; when nearly cold, and just before removing the extracts to the pots, 2 dr. essential oil of sassafras, dissolved in 1 qt. rectified spirit, is added, and quickly but completely stirred in.

(3) 16 oz. Jamaica sarsaparilla cut transversely, 280 oz. distilled water at 160° F. (71° C.), 1 oz. rectified spirit; macerate in ½ the water for 6 hours, and decant the liquor; digest the residue in the remainder of the water for 6 hours more, mix the liquors, express, and filter; evaporate by a water bath to 7 oz., or until it has a sp. gr. of 1·130; when cold, add the spirit.

(4) 3½ lb. sarsaparilla, 3 gal. distilled water; boil to 12 pints, pour off the liquor, and strain whilst hot; again boil the sarsaparilla in 2 gal. water to ½, and strain; evaporate the mixed liquors to 18 fl. oz.; when cold, add 2 fl. oz. rectified spirit.

(5) 1 lb. sarsaparilla, 4 pints boiling water; digest 2 hours; bruise the root, boil for 2 hours, filter, and express the liquid; repeat the coction with 2 pints water, as before; evaporate the mixed liquids to the consistence of a thin syrup, and when cold enough add sufficient rectified spirit to make up 16 fl. oz.

(6) 1 lb. sarsaparilla; proceed as before; add sufficient rectified spirit to make the product up to 20 fl. oz.

Scammony.—(1) Powdered scammony exhausted with proof spirit, and the resulting tincture distilled until little but water passes over; the remaining water is then poured from the resin, which is next well washed in boiling water and dried at a temperature below 240° F. (115½° C.).

Senna.—(1) *Alcoholic.*—1 oz. senna in powder, 5 oz. rectified spirit; heat gradually to boiling; let cool; in 24 hours express, strain, and repeat the process with fresh spirit; distil and evaporate.

(2) *Fluid.*—2½ lb. senna in coarse powder, 64 fl. oz. proof spirit; macerate 24 hours; proceed by displacement; subsequently add weak spirit (1 of rectified spirit to 3 of water) until 10 pints of tincture is obtained; evaporate to 1 pint, filter, add 20 oz. sugar and 1 fl. dr. oil of fennel dissolved in 2 fl. dr. compound spirit of ether.

Smoke.—(1) *Acetic.*—2 oz. wood-soot, ½ pint distilled vinegar, ½ pint water; boil to 16 fl. oz.; filter, evaporate.

(2) *Aqueous.*—2 oz. wood-soot, 1 pint water; as (1).

Squills.—*Acetic.*—Digest 1 lb. powder of squills in 3 oz. acetic acid, and 1 pint distilled water, with a gentle heat for 48 hours. Express strongly, without straining; evaporate to a proper consistence.

Stillingia.—Macerate 16 oz. stillingia in fine powder with 12 oz. rectified spirit, 3 oz. glycerine, and 1 oz. water, for 4 days in a closed percolator; proceed as for cotton root.

Stramonium.—(1) Pack coarsely-powdered stramonium seeds in a percolator; pass about their own weight of washed ether slowly through; remove the ether, and set aside; pour over proof spirit until the seeds are exhausted; distil off the spirit; evaporate the residue by a water bath to pilular consistence.

(2) 15 oz. stramonium seeds, 1 gal. boiling distilled water; macerate for 4 hours in a vessel lightly covered, near the fire; afterwards take out the seeds, bruise them in a stone mortar, and return them to the liquor; then boil down to

4 pints, strain whilst hot, and evaporate.

Taraxacum.—*Crush fresh dandelion root, press out the juice, and allow it to deposit; heat the clear liquor to* 212° F. (100° C.), and maintain the temperature for 10 minutes; then strain, and evaporate by a water bath at a temperature not exceeding 160° F. (71° C.) to a proper consistence.

Tobacco.—*Alcoholic.*—1 lb. tobacco leaves, 2 lb. spirit (sp. gr. ·900); digest in a warm place for some days, express strongly, and again digest in a mixture of 1 lb. each of water and spirit (·900) for 24 hours; again press out the liquor, and evaporate the strained and mixed liquors in a vapour bath at a temperature not exceeding 167° F. (75° C.).

Valerian.—*Fluid.*—12 fl. oz. rectified spirit; mix, add 8 oz. valerian in coarse powder, digest and percolate, adding subsequently spirit (at or near proof) until 16 fl. oz. of tincture have passed through; let this evaporate spontaneously, in a shallow vessel, until reduced to 5 fl. oz.; in the meantime add fresh spirit to the mass in the percolator until 10 fl. oz. more of the tincture are obtained, which add to the above residue of the evaporation, dissolving any oleo-resinous deposit in a little rectified spirit, and adding it to the rest; filter, and add sufficient rectified spirit to make the whole measure 16 fl. oz.

Wormseed.—1 oz. wormseed, 4 oz. ether; digest 3 or 4 days, press, filter, distil off $\frac{1}{3}$, and evaporate the residue to a proper consistence.

FIREPROOFING. — This article embraces the modern methods devised for preventing, limiting, and extinguishing fires, and may be conveniently divided into the following sections: — Buildings, Extinguishing Compounds, Paints, Textiles, Timber, Writing Materials.

Buildings.—The following observations are due to Capt. Shaw:—

To construct a building in such a way that it will resist the effects of heat and flame for any considerable time requires care and forethought in the choice of the position, a sound knowledge of the several materials to be used, and a skilful design to bring these materials into combination in such a way as to meet the proposed requirements of the structure when completed, and at the same time to avoid the consequences of extreme and sudden changes of temperature; for it should be known that some of the greatest destruction ever seen after a conflagration has been caused, not by the primary, but by the secondary effects of fire; that is to say, not by the expansion produced by heat, but by sudden contraction after the expansion. In choice of materials there is much food for reflection in connection with the safety of buildings when exposed to sudden changes of temperature. In walls, bricks of any kind, but more particularly fire-bricks, if properly laid in sound mortar or cement, will resist the effects of heat for a considerable time; stone, if laid as well in the middle as on the inner and outer surfaces, lasts a long time, unless it fails in the unsupported parts over the openings, which it always does when the lintels and the tops of the windows are made of the same material. Openings for doors and windows in a stone wall, to be safe, should be mounted on the top with brick arches, which would carry the load without any difficulty long after stone in such a situation would have become calcined, and probably allowed the whole of the superstructure to fall down. For stairs, stone is a very dangerous material, unless it is embedded on some substance which can carry it when it gets hot. Stone stairs are usually made by tailing in the ends of a number of blocks of stone a few inches into a wall, leaving some 2 or 3 ft. protruding, and hanging unsupported in mid-air. After such stairs have been completed, they present an imposing appearance of solidity and strength, and so deceive the eye; but if fixed at a height of 30 or 40 ft., and even at the ordinary temperature of the atmosphere, the block would be somewhat fragile. There can be no doubt that any sudden rise of temperature, such, for instance, as might be produced by pouring a kettle of boiling water on it, would suffice to bring it to the ground. In this case, the exposed part would expand with the heat, the supported part, being protected, would not expand, and a fracture would occur between the two, generally close to the wall. Such are some of the principal dangers of the use of stone, but of all building materials there is none which require more extreme care and delicate treatment than iron. Imagine a straight iron rod supported only at its ends, and capable, at the ordinary temperature of the atmosphere, of carrying a heavy weight in the middle. Let a strong fire be lighted under it: in a few moments the rod will lose its straightness, first sagging in the middle, then dropping altogether, next fusing, and finally running away; yet this is a material which many persons persist in calling fire-proof, and put to carry loaded floors in buildings which they designate by the same improper epithet. The employment of these materials cannot be prohibited. Therefore greater reason exists for exposing their weakness in respect of withstanding fire, and pointing out necessary precautions in their use. Wherever iron is used it should be protected by terra-cotta, good brick-work, sound plastering, or, if nothing better can be found for the purpose, solid wood-work round it. Wood-work, if really sound and solid, will resist for almost any length of time every possible effect of heat short of actual flame; even when flame has reached it, it is by no means destroyed at once, but, on the contrary, is sometimes found to last for hours; and wood protected on its under side by proper plastering, which will not fall down or crack on the application of heat, seems to be a most powerful resister of flame. It is probably to the scamping now so common that we owe the diminishing use of timber as a material for the construction of buildings destined to carry heavy loads. In this country, ceilings are made to look solid enough, and, if they were only what they represent themselves to be, they would in most cases be almost impervious to the effects of either heat or flame; but let them be pierced through, and they are found to be a sham, being a mere skin of plaster adhering to some thin strips of wood, which may be termed indifferently laths or firewood according to the taste of the observer. These strips are tacked on to the lower parts of the joists, and the spaces between them and the flooring boards over the joists are simply so many flues, commonly containing only very foul and noxious air, but capable at any moment of being converted into most dangerous hidden passages for smoke and flame. Air-passages are also found in the lath-and-plaster partitions between rooms, behind the skirting boards of rooms, and under the steps and behind the skirting-boards of stairs. All sound building is more or less good building for resisting the effects of heat; and all scamping is dangerous.

The 'English Mechanic' observes that fire-proof partitions may be constructed on the principle adopted in France. The timber frames, braces, and quarterings are filled in with rough stone rubble, and the surfaces are lathed with strong oak laths, 2 in. or 3 in. wide, every 4 in. or 6 in. apart. A coat of plaster is then applied at the same time on each side, and pressed through; the mortar thus fills up the spaces, and the rubble is rendered solid and compact. This plastering is put on thick enough to cover the timbers and laths, and to form a continuous and concreted body of material rather than a filling-in merely. Our bricknog partitions are somewhat similar, though the plastering on the latter is generally more superficial, and apt to peel off from the want of a proper key. Ceilings are sometimes formed in a similar way to the walls above described, the battens or laths being incorporated or imbedded in a body of plaster which is forced through them on a level platform fixed 2 in. or 3 in. from the laths. The joists and woodwork are thus completely immersed in a body of plaster or rubble, and are protected from fire. Staircases also are rendered unassailable by being filled in with concrete. The upper surfaces of the floors are formed on battens filled in with mortar to an even surface for tiles in cement. It is impossible that fire can find its way between these solid surfaces of plaster, and in this way walls and floors may be made practically fireproof. Our own wrought-iron and concrete floors, composed of girders, joists, and T-bars, filled in with concrete, are more elaborate adaptations, and become fireproof when the iron is encased. Floors and walls of this description are also proof against damp, noise, and dust. Our common hollow wood floors are open to all these objections, and they are certainly far behind our age and science. If architects were to fill up their joists with plaster, and form good thick ceilings with battens for flooring, or cemented and tiled floors, we should have solid instead of hollow floors everywhere, and fires breaking out in lower or other storeys would be confined between the floors, and prevented from spreading upwards, with all the disastrous consequences to bedrooms and their occupants. Good walls are essential, but the horizontal walls or floors of a building are no less so. There are some other kinds of floors and roofs that commend themselves to the building profession from their extreme simplicity and economy. One plan consists in using earthenware tubes, square in section and about 1 ft. or more long. These are turned in flat arches, and rest on iron joists 8 ft. or 10 ft. apart. Two courses of these tiles, laid at right angles to each other in cement, form a strong floor 10 ft. or more wide. The tubular tiles give great rigidity and lightness, and by breaking joint a floor strong enough for any number of people is constructed. The floor and ceiling are afterwards coated in cement stucco. Frost introduced this plan. Another kind of roof or ceiling is formed of arched pots made square at top and round at the bottom, about 4¾ in. across and about 8 in. high, having the sides and bottom screwed, and a hole to give a key to the cement. The Bank of England, the Treasury Buildings, Whitehall, Buckingham Palace, the National Gallery, and other buildings have ceilings of this description. Stone skewbacks have been used in some cases for the abutments. Again, roofs and flats of great strength, and perfectly fireproof, can be formed in a still more simple way. Two or more courses of plain tiles are laid in cement upon joists or rafters about 4 ft. apart, with battens 3 in. by 2 in., and at 11-in. intervals. Upon these the first course of tiles is laid, the second and each following course breaking joint. The upper surface can be cemented or asphalted with an inch layer. Asphalte forms an admirable covering to a roof or floor. For floors it should be laid on a bed of concrete 3 in. to 6 in. in thickness, the concrete being of clean gravel and lime in the proportion of 7 to 1 in ground floors. If laid in joists, a finer layer is necessary. When quite dry, the asphalte should be laid to a thickness of ¾ in. to 1 in., according to traffic and wear. Experiments have shown the value of asphalte in arresting fire. Although partially liquefied, the asphalte protects the timber from ignition; and a layer ½ in. thick is said to have preserved planks from ignition 1½ hour. The only asphalte fit for roofs and floors, as a fire-proof material, is not any tar compound, but the rock asphalted mastics, as the "Seyssel" and "Val de Travers," containing about 7·50 of bitumen and 92·50 of carbonate of lime. Thus one of the most effective roofs or floors is constructed of flat tiles over wooden or iron joists, concreting and then asphalting the surface.

D. O. Boyd suggests that fireproof construction depends mainly on the following points:—

(*a*) That buildings, of the warehouse class especially, should be constructed wholly of incombustible materials, and of such as are unaffected by intense heat.

(*b*) That they should be built in compartments capable of instant isolation.

(*c*) That they should be proof against fire from without.

(*d*) That in the event of fire in any one compartment, and the inevitable consumption of its contents, an intense accumulation of heat, to endanger the building generally, should be impossible.

To secure the first in a strictly sound and scientific manner, the use of wood constructionally should be discarded, and our scientific men might do good service by discovering a mode of construction with known substitutes which should dispense with its employment. The too free use of iron in exposed situations has been found most objectionable; stone has equally failed; and good honest brickwork, especially when the mortar used is fire-resisting, would appear, after all, to be the most reliable. As, however, iron must enter into the construction to admit of the large rooms required in modern buildings, it would be essential, and by no means difficult, so to isolate vertical columns, girders, and tension-rods, as to make them unaffected by the fiercest heat generated in their immediate vicinity.

The fact of the fragile wooden doors of ordinary buildings being the chief outlets for the spread of fire has scarcely been adequately noticed. No sooner is the frail door burnt through, than the fire rushes up the staircase, which thus acts the part of a huge chimney in creating a draught and increasing the fire, being itself a vehicle for transmitting the fire to other parts of the building. Even iron doors buckle and twist under intense heat, and have failed lamentably. There is, however, a description of door (of which two have been fixed for some years in the Museum of Building Appliances in Maddox Street) absolutely fire-resisting. They are partly constructed of refractory fire-clay, and are made to slide into spaces left in the thickness of the walls. They overlap the door aperture by several inches on all sides, whereby their iron framework is well removed from any possible contact with fire.

It is needless to point out the danger to which an ordinary town house is liable from the ignition of its external woodwork. Safety from external fire may be secured by the application of the same construction of fire-clay doors and shutters already described to the external doors and windows. These fire-clay shutters have been made to slide over the wall-faces both internally and externally, and, better still, into recesses in the wall itself; so that on the first alarm of fire the premises may be rendered impervious to the enemy in a very short space of time. One further source of external danger lies in the ordinary construction of roofs with wooden framings, generally as dry as tinder, and readily inflammable, even through their slated coverings in most cases. These should be universally superseded by the cheaper, more durable, and fire-resisting flat roof, now proved, by several examples, to be quite practicable when constructed of concrete, or concrete faced with tiles.

Whilst advocating the provision of all available appliances for "knocking out" incipient fire, such as hydrants, hose, &c., the necessity should, above all, be recognised for such construction as would facilitate the safe and rapid combustion—if burn they must—of the contents of any one compartment, rather than risk the contents of other compartments, through accumulated heat, by denying to the flames from a portion ignited a safe and free exit by a recognised channel. To this end a sufficient shaft should be constructed from the ceiling level of each compartment (which ordinarily would prove an excellent means of ventilation) for the purpose of discharging the fire, so to speak, harmlessly up the chimney. The condition of each compartment would be the reverse of an ordinary brick oven, which is constructed to accumulate intense heat without the slightest risk to its surroundings), whereas the arrangement under consideration would provide compartments structionally as non-inflammable as ovens, with the ever-present means of discharging instantaneously accidental fire, whereby accumulated heat would be rendered impossible.

A porous tile for fireproofing has been introduced by S. E. Loring. It consists of granular organic matter mixed with clay, the former burning out in the oven and leaving a porous tile that will bear nails being driven into it. It forms an excellent base for plaster in place of laths, and thus greatly increases the fireproof character of walls where it is applied, and may be used to surround iron columns, girders, &c.

A compound termed magneso-calcite has been successfully tried in America as a lining for safes, bank-vaults, shutters, express chests, jewellery cases, &c. It is applied to sheets of asbestos paper and paper board, and forms a tough and elastic material.

Wrought iron, as commonly employed to resist the action of fire, and even when protected by concrete, has shown itself to be entirely unreliable in fireproof structures. It is, however, well known that fireclay forms a much more efficient material for protecting wrought iron from the destructive action of intense heat, and it is with the application of this material by J. Whichcord, the engineer to the National Safe Deposit Company, that good results are obtained. The arrangement consists merely in employing a number of fireclay blocks, about 9 in. long and $1\frac{1}{2}$ in. to 2 in. thick, formed on one side with recesses of an ⌊ form, so as to fit closely to the web and bottom flange of the wrought-iron girder. The outer sides of the blocks can be made of any desired form to receive ceiling arches or joists. The blocks being placed upon the girders, meet underneath the bottom flange, and the longitudinal as well as the transverse joints are made good with fireclay. In some experiments at Erith, a furnace, 15 ft. long and 4 ft. wide in the clear, was constructed, and across the top a rolled-iron joist of I section, 17 ft. long, 10 in. deep, and with 5 in. flanges, was laid, spanning the length of the furnace. This girder was protected with blocks in the manner above described, and on each side of the girder brick arches were built abutting against the side-walls of the furnace. Over the top of the arches and girders a thickness of concrete was laid, and the floor thus formed was loaded with pig-iron to one-fourth of its breaking-weight. After the structure was thoroughly dried, a fierce wood fire was made up in the furnace, and was maintained for $2\frac{1}{2}$ hours, when large quantities of water were thrown on the heated mass. The deflection of the loaded girder had when heated amounted to $1\frac{1}{4}$ in., but when the weights were removed and the beam had cooled, the deflection disappeared, and it remained apparently uninjured, although the fireclay sheathing was vitrified on the surface. A second experiment was made, when a fierce fire was kept up for $1\frac{1}{2}$ hour, and then maintained moderately for 28 hours more, after which it was suddenly extinguished with cold water. The deflection of the loaded girder had been $\frac{3}{32}$ in. at the commencement of the trial, and reached a maximum during the fire of $1\frac{3}{16}$ in., reduced to $\frac{3}{8}$ in. when the load was removed, but before the beam was cool. Ultimately, however, it returned to the original amount of $\frac{3}{32}$ in. Altogether this experiment, which was carefully carried out, shows the enormous resisting power of the fireclay blocks, and it may be mentioned that one end of the girder which projected through the brickwork of the furnace was quite cool when the fire was at its hottest, and no appreciable expansion was observed. The beam will be employed in the building for which it was originally intended.

Extinguishing Compounds.—(1) 8 lb. carbonate of soda, 4 lb. alum, 3 lb. borax, 1 lb. carbonate of potash, and 24 lb. silicate of soda solution are mixed together; $1\frac{1}{2}$ lb. of this mixture is added to each gal. of water when required for use. The object is to cover everything with a fireproof film or deposit.

(2) A committee of the Polytechnic Society of Munich has lately issued a report on the means to be adopted for extinguishing burning petroleum. This states that since concentrated water of ammonia evolves a great amount of gas when heated, and this gas is unable to

sustain the combustion of any substance, it may be asserted that petroleum will not continue to burn even in a room filled with atmospheric air wherein a considerable proportion of ammonia gas is present. The place where the petroleum is stored must be broken up in compartments, so as to limit the bulk. The ammonia water must contain at least 10 per cent. of the gas. The proposed method of employing the agent is to keep a bottle full of it on each cask; the bottle and its contents would remain intact till fire caused the destruction of the one and the liberation of the other, so that there would be no loss except when needed.

(3) The now well-known *extincteur* introduced by Sinclair is a vessel filled with water charged with carbonic acid gas under great pressure.

(4) Foster, of Bolton, has introduced an *extincteur* in the form of a portable pump, which can draw a continuous water supply from any source, and saturate it with carbonic acid under pressure before emitting it in a jet.

(5) The carbonic acid is produced by decomposing a carbonate by an acid. If sulphuric acid be poured on a solution of soda carbonate, violent effervescence takes place, because the latter consists of carbonic acid gas combined with sodium oxide; the stronger acid (sulphuric) displaces the weaker, and itself combines with the sodium oxide to form soda sulphate, setting free the carbonic acid in a gaseous form. If this occurs in a close vessel, the carbonic acid accumulates with increasing pressure. In *extincteurs*, different means are adopted for liberating the sulphuric acid when action is to take place. In Sinclair's, a strong metallic vessel is nearly filled with soda carbonate solution, the acid being kept in a stoppered bottle in the midst of the solution. For use, the bottle is broken, with consequent liberation of the acid and generation of the gas, which is let out by a tap and tube. In Merryweather's, the acid is kept in a bottle with a loose-fitting stopper, and for use, the whole apparatus is momentarily inverted, thus pouring the acid into the solution; in this way, fragments of glass from the bottle are avoided. In Shand and Mason's, the acid bottle is broken by a weight falling upon it, and provision is made for straining back broken glass from the outlet pipe.

(6) Dumas has discovered that water saturated with alum has superior value in extinguishing fires—a value supposed to be due to the coating it gives to objects wet with it, which prevents contact with the oxygen of the air, and thus diminishes the rapidity of the combustion. Experiments are to be made by supplying the firemen of Paris with instruments to throw it.

Paints.—(1) Various substances have been proposed as fireproof coatings for the protection of woods employed for building purposes, but most of them have been abandoned as being either too costly or not sufficiently durable. The following, invented by Vildé and Schambeck, seems to succeed. The paint consists of 20 lb. finely-pulverized glass, 20 lb. finely-pulverized porcelain, 20 lb. any sort of stone in powder, 10 lb. calcined lime, and 30 lb. water glass (silicate of soda), such as usually found in commerce. The solid elements, having been powdered as finely as possible and sifted, are moistened and then intimately mixed with the water glass. This yields a mass of syrupy consistence that may be employed for painting either alone or mixed with colour. The addition of the lime gives a certain unctuosity to the mass for whitewashing, and its combination with the silicic acid of the soluble glass serves to bind the other materials together. The proportions of the different elements above mentioned may be changed, save that of the water glass, which must remain constant. These elements may even be replaced one by another; but it is always well to preserve the lime. Instead of the silicate of soda (soluble glass of soda) soluble glass of potash might be used, but the former is less expensive. The coating is applied with a brush, as other paints are, as uniformly as possible over the surface to be protected. The first coat hardens immediately, and a second one may be applied 6 hours or more afterwards; two are sufficient.

(2) Take of common lime, freshly slaked, of hydraulic lime, and of siliceous or argillaceous matter (sand or pulverized slate), equal parts; to which add cows' milk in sufficient quantity to give the whole, when thoroughly mixed, the proper consistency for laying and spreading with the ordinary brush. Any desired colouring matter may be added. The addition of glue or resin may in some cases be of value. The proportions may vary considerably, but those above given are considered to produce the best result.

(3) Dissolve crushed rosin in turps sufficient to make it as thick as cream. Then mix together in a paste oxide of zinc and boiled linseed oil, and add it to the other; it will become white. Thin it out for use with boiled oil and turps. The above paint will take most pigments, and should be put on flowing.

(4) Two substances are in general use for the purpose of protecting wood against combustion, viz., zinc chloride and soda silicate. Both of these have certain drawbacks. A paint consisting of zinc chloride volatilizes when the material on which it is spread is heated or exposed to flame, and its vapours are unsupportable by human beings. It would therefore be difficult, if not altogether impossible, to enter wooden dwellings painted with the zinc salt when on fire, and thus the salvage of furniture, &c., would be obstructed. The water-glass paint, on the other hand, is liable to be washed away when exposed to rain or other watery influences. Siebürger therefore recalls to mind two fireproof compositions which were formerly in much use. The one is a saturated aqueous solution of 3 lb. alum and 1 lb. copperas, with which the wood is twice painted; after drying, a solution of copperas in which powdered clay is suspended is brushed over the alum layer. The other protective paint is a mixture of 1 lb. sulphur, 1 lb. clay, and 6 lb. copperas, spread as powder over wood previously washed with a solution of glue. (*Ding. Polytech. Jl.*)

(5) A "fireproof paint," introduced by the United Asbestos Co. of London and Birmingham, is intended to render uninflammable woodwork, &c., which in case of fire forms the main source of supply to the flames. The fire-resisting properties of the compound have been thoroughly tested, and the results were satisfactory. A gauze curtain stretched upon a wire frame, and having the name of the company painted upon it, was set on fire, and immediately consumed with the exception of the material so painted, which exhibited only slight symptoms of contact with the flame. Perhaps the most important test, however, was that afforded by two wooden models of theatres, fitted with curtains, proscenium, and all the usual surroundings. One of these was painted over the whole exposed surface with the asbestos paint, the other being left in the ordinary condition. Petroleum was plentifully dashed over both erections, which, being also filled and surrounded by shavings, were then set on fire. In 10 minutes the theatre not treated with the preparation was reduced to a mass of charred timber, whilst the other, though exposed to heat quite as fierce, stood the test admirably. The painted woodwork was simply blistered; an asbestos curtain was preserved intact; and the asbestos ropes representing those used in the lowering and elevation of scenes, &c., were in no way injured. Finally, several blocks, both of prepared and unprepared wood, were placed upon a coal fire, the blocks painted with the compound resisting the action of the heat for a much longer period than the others, some specimens being shown afterwards as mere shells, of which the interior had all burned away.

(6) Mountford's paint consists of asbestos ground and reground in water, potash or soda aluminate, and potash or soda silicate. When it is to be exposed to the weather, it is combined with oil, driers, and gummy matters, and in some cases with zinc oxide or barytes. It is

used on the Exhibition buildings at South Kensington, and elsewhere.

Textile Fabrics.—Several preparations for rendering textile and other inflammable fabrics incombustible and practically fireproof have been recently introduced by Martin and Tessier, of Paris. The compositions are said to be of an inexpensive nature, and capable of rendering incombustible all kinds of readily inflammable substances, such as woven and other fabrics of cotton and other fibrous materials, paper, printed or otherwise, including bills of exchange and other securities, woodwork, theatrical scenery, straw, &c.

(1) The first composition, which may be applied to all kinds of fabrics, without deteriorating them in any way, consists of sulphate of ammonia (pure), 8 lb.; carbonate of ammonia, 2·5 lb.; boracic acid, 3 lb.; borax (pure), 1·7 lb.; starch, 2 lb.; water, 100 lb. It is simply necessary to steep the fabrics in a hot solution composed as above until they have become thoroughly impregnated, after which they are drained and dried sufficiently to enable them to be ironed or pressed like ordinary starched goods.

(2) A second composition, to be used for theatrical scenery (or the mounted but unpainted canvas to be used for this purpose) and also for woodwork, furniture, door and window frames, &c., is to be applied hot with a brush like ordinary paint. It is composed of boracic acid, 5 lb.; hydrochlorate of ammonia or sal-ammoniac, 15 lb.; potash felspar, 5 lb.; gelatine, 1·5 lb.; size, 50 lb.; water, 100 lb.; to which is added a sufficient quantity of a suitable calcareous substance to give the composition sufficient body or consistency.

(3) A third composition, to be used for coarse canvas or sailcloth, cordage, straw, and wood, is applied by immersing the articles therein or by imbibition, and consists of boracic acid, 6 lb.; hydrochlorate of ammonia or sal-ammoniac, 15 lb.; borax (pure), 3 lb.; water, 100 lb.

(4) A fourth composition, applicable to all kinds of paper, whether printed or not, including securities, books &c., is formed of sulphate of ammonia (pure), 8 lb.; boracic acid, 3 lb.; borax, 1·7 lb.; water, 100 lb.

The solution is to be placed in a vat heated to 122° F. (50° C.) at the end of the paper-making machine, and the paper as it leaves the machine is passed through the solution in this vat, so as to be completely impregnated therewith, after which it is dried upon a warm cylinder and then wound on a reel. If the paper be in sheets or printed, it is simply immersed in the above heated solution, spread out to dry, and afterwards pressed to restore the glaze destroyed by the moisture. The above compositions ensure a degree of incombustibility without precedent as regards the preservation of the materials to which they are applied. The proportions of the several ingredients are given as examples only, and may be varied as found necessary in practice.

(5) The 'Manufacturers' Review' translates from Hager the following directions for preparing a starch paste, impregnation with which renders a fabric incombustible:—10 lb. calcined and pulverized bones are treated with 50 lb. hot water, to which 6 lb. concentrated sulphuric acid are gradually added. The mixture is well stirred, and left to stand 2 days in a warm spot, being stirred from time to time; 100 lb. distilled water are then added, and the liquid filtered. 5 lb. sulphate of magnesia (Epsom salts) are dissolved in 15 lb. distilled water, the solution is added to the first, and caustic ammonia is added till the liquid smells of it. The precipitate is thrown on a linen filter, pressed, dried in a moderately warm place, and rubbed to a very fine powder. Of this powder, 2 lb. are mixed with exactly 1 lb. tungstate of soda, 6 lb. wheat-starch, and a little indigo blue to impart a bluish tint to the powder. In order to use this powder, it is stirred up with about twice its weight of cold water, and enough hot water is then added to produce a gelatinous liquid, in which the fabrics that are to be rendered incombustible are steeped.

(6) An old recipe for rendering cot-

ton goods uninflammable is to add to the starch-size 15 lb. borax for every 1000 lb. size.

(7) To render ladies' clothing uninflammable it has been proposed that the materials should be sized with starch containing ammonia sulphate, a mixture of phosphoric and boracic acid, or in some cases tungstate of soda. Professor Gintl, in a recent report on the "dressings" for textile fabrics sent to the late Vienna Exhibition, observes that a considerable amount of ignorance appears to prevail amongst manufacturers in the choice of the substances employed. In very many instances the dressing is not as harmless to the colours of the material as it professes to be, neither does the latter gain the requisite degree of uninflammability. His experiments have led him to recommend ammonia alum and hyposulphite of soda, both of them very cheap, as suitable substances for the purpose. (*Neue Gewerbe Zeitung.*)

(8) The French Société d'Encouragement pour l'Industrie Nationale awarded a sum of 1000f. to Martin for his preparations, which have been variously tested by a committee of the society. The report briefly is that Martin's mixtures render tissues and the superficial parts of wood uninflammable, that they do not alter the tissues or colours on them, and that stuffs so rendered uninflammable retain this property after having been exposed several months, either in a stove at 97° F. (36° C.), or or on the stage of a theatre. Martin's preparations are said to have been used with success for decorations in the Théâtre des Variétés and the Théâtre des Nouveautés, and at the Théâtre du Châtelet, in the *Venus Noire* for rendering uninflammable the masts of vessels in which a fire is simulated every night by means of oakum wrapped round the masts. Martin has also been charged to render uninflammable the large sheets employed for covering goods at night in the *magasins* of the Louvre.

(9) The Abbé Maurau proposes to render textile fabrics of various kinds uninflammable, without affecting their colour, suppleness, strength, or wearing qualities, by treating them with a preparation of borax, sulphate of soda, and boracic acid, combined in suitable proportions. (*Revue Indust.*)

(10) Tremaux states that a more or less concentrated solution of sulphate of potassium and alum applied to textile fabrics prevents them from flaming (not from burning without flame) when a light is applied to them, and is in this respect as good a preservative as is to be met with. (*Comptes Rendus.*)

(11) In consequence of the fire at the Vienna Ring Theatre, the question of rendering tissues incombustible has again been ventilated, and fresh trials have been made in Berlin with apparently new substances. On closer examination, however, it was found that these substances have been used from time to time, and that a large number of similar trials was made about 50 years ago. Gay-Lussac proposed to saturate tissues with ammonium carbonate. Chevalier used this salt in conjunction with borax. Fuchs recommends the use of sodium silicate (soluble glass). Versmann and Oppenheim employed ammonium phosphate alone, and with sal-ammoniac, ammonium sulphate, and sodium tungstate. Abel impregnated tissues with lead silicate, first soaking them in lead acetate, and then immersing in a solution of sodium silicate, and rinsing. The following solutions have been successfully applied for rendering tissues incombustible:—(*a*) A mixture of sodium tungstate solution of 25° Tw. and 3 per cent. sodium phosphate; (*b*) 6 lb. alum, 2 lb. borax, 1 lb. sodium tungstate, 1 lb. dextrine dissolved in soap water; (*c*) 5 lb. alum, 5 lb. ammonium phosphate, 100 lb. water; (*d*) 3 lb. borax, 2¼ lb. Epsom salts, 20 lb. water; (*e*) 8 lb. ammonium sulphate, 2½ lb. ammonium carbonate, 3 lb. boracic acid, 2 lb. borax, 2 lb. starch, 100 lb. water. (*Indust. Blät.*)

(12) Hosemann takes a solution of calcium chloride at 22° to 49° Tw., or in its place, aluminium or magnesium chlorides. He adds hydrochloric acid in the proportion of 1 lb. acid to 75 or

100 lb. of the solution, and stirs into the liquid 10 to 30 lb. potato starch. The liquid is heated to boiling, and 5 lb. steatite, previously stirred up in 1 gal. water, is added. While continuing the heating and agitation there are added 1 lb. ammonia sulphate dissolved in ½ gal. water, 3 lb. potash silicate dissolved in 30 lb. water, and lastly 5 lb. soda or lime bisulphite. The stirring and heating are maintained for ½ hour after the addition of all the materials. Thus is formed a whitish gelatinous mass, which may be used like starch or dressing. Articles saturated or coated with this mixture are uninflammable. A more simple composition may be obtained by adding potato starch to a solution of calcium chloride at 49° Tw., and heating to 167° F. (75° C.); having well stirred and continued to heat, 1 or 2 per cent. of soluble silicate of potash is added, and the liquid, which is alkaline, is neutralized by addition of an acid or acid salt. (*Mon. Prod. Chim.*).

Timber.—(1) By Payne's process, patented in 1841, the timber is enclosed in a close iron vessel in which a vacuum is formed. A solution of sulphate of iron is then admitted into the vessel, which instantly insinuates itself into all the pores of the wood, previously freed from air by the vacuum, and after about a minute's exposure, impregnates its entire substance. The sulphate of iron is then withdrawn, and another solution, of muriate of lime, thrown in. The two salts then react upon each other and form two new combinations within the substance of the wood—muriate of iron and sulphate of lime. Timber thus treated is preserved both from rot and from the attack of worms, and is perfectly incombustible.

(2) Dr. Burnett's process consists in treating the timber to a solution of chloride of zinc, 1 lb. chloride of zinc to 4 gal. water. It requires to be immersed for about 2 days for each inch in thickness, and afterwards left to dry for a period of 14 to 90 days. This renders the wood incombustible, but not so thoroughly so as the former process. It is likewise a preservative.

(3) There are many chemicals employed to render articles uninflammable, such as common salt, sulphate of ammonia, tungstate of soda, &c. The wood would require to be thoroughly dried, and then saturated with one of the above salts dissolved in water. The woods least inflammable are beech, oak, American elm, plane-tree, and other non-resinous woods.

(4) A trial at Devonport Dockyard, ordered by the Admiralty, of the method of rendering wood uninflammable by saturating it with tungstate of soda, showed that the prepared wood is under all circumstances much less readily inflammable than ordinary wood; that shavings and chips of the prepared wood, although they may be made to burn, cannot be made by themselves to set fire to substantial timbers of the prepared wood; that prepared timber steadfastly resists mere flame, although it may be made to burn when acted upon continuously by great heat. The cost of preparation and the largely increased weight of the prepared wood are disadvantages to be set against these advantages.

(5) Some years since, experiments were made by Prof. Pepper, with a view of rendering articles fireproof by the use of chemical solutions. The following were the results:—Treated with alum, the article soon yielded, and burst into flames; with borax, it lasted longer; with tungstate of soda, longer still; with phosphate of ammonium, it resisted best of all.

(6) Wood can be rendered practically fireproof by first drying it thoroughly and then coating it with common whitewash. If the wood is not thoroughly dry, the coat of whitewash shells off, but it is a very difficult matter to burn wood which has been plastered over with whiting or even limewash.

Paterno reviews several substances which are used; some of them, as sodium tungstate, answer very well, but are objectionable on account of cost. The author has made numerous experiments with various substances in their power of rendering fabrics non-inflammable. He recommends the following as being quite equal to sodium tungstate.

(7) A mixture of borax and sulphate of magnesia. To prepare this, for 20 lb. water take 3 lb. borax and 2¼ lb. sulphate of magnesia. The action of this mixture depends on the formation of a borate of magnesia, insoluble in water, hot or cold, which surrounds and impregnates the threads of the texture or the fibres of the wood, and thus renders the development of combustible gases and the spread of flame very difficult.

(8) A mixture of sulphate of ammonium and sulphate of lime, or gypsum, in various proportions according as it is to be applied to materials of greater or less fineness. The sulphate of lime is transformed, with the salt of ammonium, into a double compound, which produces none of the disagreeable effects of the latter, or at least in a very slight degree. The action of this mixture of salts—which on account of its cheapness may be extensively employed—depends on an incrustation of the fibres, which prevents the spread of fire, and, on the other hand, extinguishes flame in consequence of the volatilisation of the salt of ammonium at a high temperature. Take 1 lb. liquid ammonia and 2 lb. sulphate of lime, and a single coating with a concentrated solution of this compound, which costs little, suffices to preserve wooden structures from burning. The wood is not rendered absolutely incombustible, but it is not easy to light, and ceases to burn when the action of foreign inflammable substances comes to an end. Roofing often washed with rain-water, and presenting every condition favourably for easily taking fire, was impregnated with this mixture. It had been covered with a layer of tar and drying oil, and thus rendered more liable to burn. Nevertheless, all attempts to set it on fire failed. The experiments made have been so satisfactory that the Austrian Minister of Finance has recommended this method to be used in all the establishments of the empire. (*Oest. Zeit. für Berg-u.-Hüt.-W.*

Writing Materials.—(1) A really incombustible paper, without a fireproof ink, would be a very valuable article in many businesses, and for many purposes of every-day life, but if it can be supplemented by a fireproof ink, its value will be enhanced tenfold. Such a discovery G. W. Halfpenny believes he has made, and that paper prepared by his process, under such circumstances as fires in houses, factories, or other buildings, is "ordinarily incombustible." The inventor prepares his paper in the usual manner from a pulp consisting of vegetable fibre, asbestos, alum, and borax, in or about the following proportions:—Vegetable fibre, 1 lb.; asbestos, 2 lb.; borax, $\frac{1}{10}$ lb.; and alum, $\frac{1}{5}$ lb. The vegetable fibres are minutely divided, and treated in the manner usual in the production of ordinary paper; the asbestos is also divided as much as possible, and the two are then intimately mixed with the alum and borax in a sufficient quantity of water to make a pulp of the requisite consistency, which is then made into paper by any of the well-known processes. The proportions given may be varied to suit the quality and nature of the desired product, and also to suit the different qualities of the raw materials. Thus the inventor says he has made incombustible paper in which the proportions of the ingredients varied from 50 to 70 parts of asbestos, and from 30 to 50 parts of flax or other vegetable fibre, with only 2½ per cent. each of alum and borax. He proposes to use in some cases silicate of soda, in order to ensure hardness and coherence in the substance of the paper after it has been acted upon by fire. In order to obtain a paper of great strength and flexibility, the sheets may be made of linen or other woven fabric, and coated on both sides with the incombustible paper. The fireproof ink for use in writing or printing on the incombustible paper is made of the following substances:—Graphite, 22 dr.; copal or other resinous gum, 12 gr.; sulphate of iron, 2 dr.; tincture of nutgalls, 2 dr.; and sulphate of indigo, 8 dr. These materials are mixed together and boiled in water, the graphite of course being reduced to an impalpable powder. This ink, which besides being fireproof is said to be insoluble in water, under ordinary circumstances is black; but when coloured inks are desired, the graphite is replaced by an earthy or mineral pigment of the desired colour.

(2) Fire-proof paper was prepared by L. Frobeen by bleaching choice asbestos fibres with sulphurous acid, and adding 5 per cent. of ground wood-fibre with borax or glue-water, and worked into paper; it can be nicely smoothed, and is said to resist a white glow heat.

(3) The 'Chemiker Zeitung' gives the following modes of preparing incombustible writing and printing paper, which appear worth attention:—The best asbestos is treated with a preparation of permanganate of potash and then with sulphuric acid; 95 per cent. of this asbestos is mixed with 5 per cent. of wood-pulp in water containing borax and glue. A fireproof writing-ink is made by mixing Indian ink and gum with chloride of platinum and oil of lavender; for printing-ink lampblack and varnish are to be substituted.

(4) Paper made of pure asbestos resists a high temperature without material alteration. An ammoniacal solution of nitrate of silver, coloured with a little Indian ink, will preserve a legible copy when written with on the asbestos paper mentioned above, and subjected to strong heat.

(5) A free-flowing ink for writing on fireproof paper with an ordinary metallic pen may be obtained by using 5 parts dry chloride of platinum with 15 of oil of lavender, 15 of Chinese ink, and 1 of gum-arabic, adding thereto 64 of water. When the paper is ignited after being written upon with this ink, the platinum ingredient causes the writing to appear transparent, and, as a consequence, it is claimed that such writing as has become black or illegible will become readily legible again during the process of heating the paper. Colours for painting may also be made fireproof by mixing commercial metallic colours with the chloride of platinum and painters' varnish, adding an ordinary aquarelle pigment to strengthen the "covering power" of the colour. These fireproof paints or colours can be easily used in the same manner as the common water-colours, and it is claimed they will resist the destructive influence of great heat quite as successfully as the fireproof printing and writing inks just referred to.

Much useful information will be found in W. G. McMillan's paper on "Some Causes of Fire and Methods for their Prevention" (*Jl. Soc. Arts*, vol. xxxi., No. 1581, pp. 380–96).

GELATINE, GLUE, AND SIZE.

GELATINE, GLUE, AND SIZE.—These substances may be considered as merely varieties of the same material, exhibiting no essential difference in composition or character; in fact, glue and gelatine pass insensibly into each other, glue being but an impure or discoloured form of gelatine, while size is practically identical with gelatine. The three substances differ only in their application and degree of purity; hence their preparation may be conveniently described under one head.

The materials seen by Dr. Ballard in use for the manufacture of glue are the following:—

(*a*) "Wet" materials: sheep-pieces or "spetches" from fellmongers; "fleshings" from leather-dressers and tanners; roundings of hides previously limed; the ears of animals; portions of bones to which tendons are attached; clippings of salted and alumed skins used for covering cricket-balls, &c.

(*b*) Dry materials: damaged pelts (Australian); ox feet salted (Australian and South American); calves' pates (German, &c.); horn "sloughs" (the pith or core of horns); clippings and roundings of parchment; glue pieces from fellmongers, leather-dressers, tanners, "pickers" hide works, and trotter-boilers; rabbits' pelts, and shreds from furriers.

Prior to making glue of them, all the soft tissues or materials used require to be limed. Such of them as come to glue-works from the leather-dressers and tanners, and some that come from the trotter-boilers, as well as the dry glue pieces and parchment clippings, have been limed already. But such as have not been limed are soaked first in pits containing milk of lime. After the liming, however, the lime has to be got rid of, or "killed." With this object, the limed materials are well washed with water. This washing is effected in tanks or vats, or in pits. At some works the washing is effected speedily in large barrels so arranged inside as to throw about the materials by revolution of the barrels. In the case of dry glue pieces, however, it is found sufficient to expose the material to the free action of the carbonic acid of the atmosphere, by spreading for a prolonged period on racks in erections, covered, but open at the sides, provided for the purpose. When thus prepared, the materials are ready for boiling. But in some works they are subjected, after being washed, to pressure in a hydraulic press.

The boiling is effected in large open pans or boilers, of which there are usually several together. The pans are each capable of containing several tons of materials. In Young's works at Bermondsey the charge of each pan is 12 tons of fleshings with 1 ton of water, the produce of which is said to be about 25 cwt. of glue. A clear space is kept at the bottom of the pan by means of a false bottom of bars. A clear space in the middle is also kept by means of a vertical framework, which can be taken out and replaced at pleasure. The object of this frame and false bottom is partly to give free space for circulation of liquid during boiling, partly to prevent burning, and partly to assist the straining off of the liquid glue. The materials are boiled either by means of a fire beneath the pan or by means of open steam, or by means of both open and close steam. In some works both means (a fire beneath the pan and steam) are provided for the same pan. The pans are usually raised upon a platform approached by a ladder or steps, and are arranged under a roof or shed open at one or on all sides. When horn "sloughs" are used, it is customary to build them up around the outside of the central framework, before putting in the other materials. During the boiling a man is employed in stirring up the contents of the pan from time to time, and in skimming off the fat which rises to the surface.

When the boiling is completed, the fire is raked out, sufficient time is given for settling and partial cooling, and then the liquid glue is drawn out from the space beneath the false bottom along a wooden channel, in which lumps of alum are laid, to wooden troughs ("coolers") on the ground and about 1 ft. wide and deep, in which the liquid is left to solidify into a very firm jelly or size.

During the solidification, froth and some fatty matters rise to the surface, and in some works these are skimmed off; in other works they are left to solidify with the glue, and are dealt with in the next process.

This process consists in cutting the contents of the troughs into slices. The solidified material is taken in blocks from the troughs, and cut upon a bench into slices by women. When there is any scum on the surface of the blocks, it is first cut off and put aside to be returned to the pans.

The slices thus cut off are carried to sheds or erections open on all sides to the air, and are there laid upon nettings to dry spontaneously. When perfectly dry and hard, any mouldiness upon them is scrubbed off with a brush and warm water by women, after which they are laid on a rack to drain and dry, and are finally removed to a chamber heated artificially to between 85° and 120° F. (29° to 49° C.) for a final drying.

The matter left in the pans after boiling is termed "scutch." It is commonly thrown out of the pans in a heap upon the ground, sometimes under the shed where the pans stand, and sometimes in the open air, where it remains until removed to the manure-makers. Sometimes it is sent to the manure-makers in the condition in which it leaves the pan; at other works it is previously deprived of fat, and at others it is made into manure on the premises, without any previous removal of the fat it may contain. The "sloughs," when taken from the pans, are set aside in a separate heap for the use of bone-manure makers.

Size of very different qualities is made at glue-works. Some, destined for rough work, is made of similar materials to ordinary glue, while other varieties, of a fine quality, destined for the manufacture of gelatine and for use in soups, are made with especial care and precautions, and of very carefully selected pieces, such as "calves' pates." It is important that after liming, the lime should be more completely removed than is necessary for glue-making, and for this purpose the pieces are first treated with a weak solution of hydrochloric acid. The boiling is effected in a similar manner to that of glue, except that free steam is more frequently used for heating the contents of the pans than in glue-making. The liquid size is either run out into little tubs for sale, or into a large vat, out of which it is taken and broken up for packing in tubs. The finest kinds of size for esculent purposes are made into blocks. Steam-jacketed pans are used in making such kinds. Some of the fine kinds of size made at ordinary glue-works go to the paper-makers. Size is sometimes made by first acting upon horn piths with hydrochloric acid, and then boiling them with water.

According to another account, the liming process consists in steeping for some weeks in a pit with lime-water. The object of it is to remove any blood or flesh adhering to the skin, and to form a soap with any fatty matters present. During the boiling, test-samples of the liquor are taken from the boiler at intervals and examined as to their consistence; when a sample in cooling forms a stiff jelly, the charge is ready to be drawn off. The first boiling generally occupies about 8 hours; and when a charge of liquor has been withdrawn, the boiler is replenished with fresh water, and the boiling is continued. The complete exhaustion of the gelatinous matter is only effected after 6 boilings, occupying about 48 hours. The successive charges deepen in colour till the last. The boiling must not be protracted beyond the point necessary for yielding a stiff gelatinous solution, otherwise the long-continued heat will have the effect of destroying the congealing power of the gelatine. Before passing to the coolers, the liquor is kept for some time in "settling-backs" in a fluid condition, to allow mechanical impurities to settle out. The coolers measure 6 ft. long, 2 ft. wide, and 1 ft. deep. When the glue has set, a little water is run over its surface to facilitate its being cut into slices about 1 in. thick. The drying is the most delicate and difficult operation, and the characters of our climate have much to do with the inferior quality of the glue produced here as compared with that made in France. Simple air-drying affords the best article but the plastic masses must be protected from rain, frost, and strong dry heat—hence spring and autumn are the most favourable seasons, when the drying may be effected in 12 to 18 days. The cutting of the glue into thin slices is performed by means of a wooden box with slits in it at suitable intervals, and a brass wire attached to a bow. The square blocks from the coolers are placed in these boxes, and thus held securely while being operated upon by the wire. The slices are spread on nets attached to wooden frames, which are placed in piles in a field, with proper intervals for the admission of air, and each pile is roofed over for protection from the weather. The slices are turned 2 or 3 times a day, and for this purpose the roof is lifted off the pile, and the uppermost frame is placed on the ground. The slices are turned one by one, and then the second frame is lifted off and set on the first, and so on till a new pile is formed, when the roof is replaced.

During the drying, the glue is more likely to receive injury than at any other period. In very warm weather, the cakes are liable to become so soft as to lose all shape and unite with the frames, or they may even melt entirely and flow away. A thunderstorm sometimes prevents a whole field of glue from hardening, while a thick fog may make it all mouldy. A brisk drying wind may harden it so suddenly as to render it unsightly and unfit for the market. A hard frost, by freezing the water in the glue, may cause it to crack in all directions, rendering remelting necessary. Thus the manufacture has many vicissitudes to suffer, and can only be profitably and conveniently carried on in temperate and equable weather. The drying, however, is not entirely finished in the open air. When the glue is about three parts dry, it is removed to lofts, where in the course of some weeks or months the hardening is completed. But as the surfaces of the cakes become mouldy and soiled, it is at length necessary to scour them with a scrubbing-brush and hot water, and set them up to drain. They are then finally dried off in a stove-room at an elevated temperature, which, when they are once solid, only serves to harden and improve them.

To obviate the ill consequences of extremes of temperature and changes of weather in the manufacture of glue, Fleck proposes desiccation in the presence of certain salts. When a solution of gelatine is treated with ammonia sulphate, magnesia sulphate, or Glauber's salts, the gelatine contracts into an elastic mass no longer susceptible of fermentation, and containing but 18 per cent. of water. Mixed with fresh glue, which contains 80 or 90 per cent. of water, it makes a glue of medium consistency, easily soluble, containing 53·4 per cent. of water, and resembling that prepared for cloth-workers' use by Stalling of Dresden. Undried glue contains 72 to 93 per cent. of water; glue carefully dried in the air, 12 to 15 per cent. only. The problem is therefore to eliminate 60 to 80 per cent. of the water as speedily as possible without injury to the quality of the glue. If the bottom of a flat vessel be covered with a layer of the above-mentioned salts, and the sheet of glue laid thereon between 2 damp cloths, the salts quickly deliquesce. At the end of 12 or 18 hours, this ceases, and the sheets will be found to contain 25 per cent. of water only. Desiccation can thus be effected without the risks of melting and putrefaction in summer or congelation in winter. The glue gains rather than loses in respect of adhesive powers. It, however, retains 3 to 6 per cent. of the salts employed, which, although they do not impair its quality, give it a dull appearance, like Russian glue. The salts can be dried by evaporation, and used over again. (*Mon. Indust. Belge.*)

It appears from the observations of Schattenmann, a glue-maker, that fresh glue dries much more readily than glue that has been once or twice melted; and that dry glue steeped in cold water absorbs different quantities of water according to the quality of the glue; and the proportion of water so absorbed may be used as test of the quality of the glue.

It seems that fresh glue contains water of composition, or water more intimately united with the glue than water mixed with it in the process of melting, which admits of being readily disengaged by evaporation. The combined water of dry glue disappears in the course of successive meltings and solidifications to which glue is subjected. Glue in thin plates is usually of better quality than thick ones, even when made with the same kind of gelatine, because the thin plates admit of a more complete drying than the thick. In applying Schattenmann's test, dry glue is immersed for 24 hours in water at the temperature of about 60° F. (15½° C.). A jelly will thus be formed, the qualities of which will fairly represent those of the glue. For example: the finest ordinary glue, or that made from white bones, absorbs 12 times its weight of water in 24 hours, so that a plate weighing 3 gr. produces 39 gr. of fine elastic jelly. Glue from dark bones absorbs 9 times its weight of water, and produces not quite so fine a jelly. The ordinary glue of Alsace or of Germany, made from animal refuse, absorbs 5 times its weight of water, producing a soft brown jelly, without elasticity and consistence, and falling to pieces when handled. The common glue of Boulogne absorbs 3½ times its weight of water.

Well-dried glue is much less hygrometric than badly-made glues or those made of inferior materials. The latter are liable to putrefaction. The water of composition seems to be injurious to the strength of glue, which increases in proportion to its dryness.

Following are some observations of the chemical characters of commercial glue not generally known. Analyses of two samples of white glue of the best grade yielded the following results:—

	'No. 1 extra C" glue.	Frozen glue.
Moisture (loss of weight at 212° F.)	16·70	16·28
Gelatine, with a little animal fibre and fats	79·85	80·42
Carbonate of lime	1·42	1·33
Sulphate of lime	0·41	0·34
Phosphate of magnesia	0·35	0·31
Alkaline salts	0·17	0·12
Silica, oxide of iron, &c.	0·09	0·08
Oxide of zinc	1·01	1·12
Total ..	100·00	100·00

Analyses of 10 more samples of frozen and sheet glue, of common grades and from different makers, showed the proportion of water contained in them to vary from 14 to 18 per cent., averaging 17 per cent. And the proportion of ash or mineral matter varied from 3 to 6 per cent., averaging rather less than 4 per cent. Two of these samples contained about 1 per cent. of white zinc, and two of them contained sulphate of lime. Analyses of 2 samples of commercial gelatine averaged 16½ per cent. of water, and 2·56 and 3·11 per cent. of ash respectively. There was no oxide of zinc or sulphate of lime in these gelatines. The presence of so much water was quite unexpected; and as the quantity is nearly the same in fresh and in seasoned specimens, it is not a make-weight, although steam is very freely used in the rooms where glue is packed by the manufacturers. The carbonate of lime comes from the quicklime used for cleaning and preserving the animal matter, or glue stock, while the sulphate of lime is formed by the addition of small quantities of sulphuric acid during the process of manufacture, to neutralize the lime that is carried forward by the solutions of glue. The oxide of zinc is said to be added to prevent souring, or the acidity caused by decomposition, and it also improves the colour of the glue; but it is not generally used, as these analyses indicate. The impure glues, or those containing the most mineral matter, became almost insoluble after they had been broken into small pieces and heated in a hot-air bath (copper oven) at 212° F. (100° C.) for 2 or 3 hours, until they cease to lose weight; they then soften and become dough-like, but do not dissolve when boiled in water for some time. The purer gelatines were not so much injured, and one specimen, containing only 2·56 per cent. of ash, was not materially affected by this thorough drying. The solid sheet glue, while drying in this way, tumefied and became very porous: the frozen glue did not alter in structure. The conclusion drawn from these experiments was that the excess of lime combines with the gelatine, and perhaps with the extraneous animal matters of the glue, at the high temperature, forming a compound like lime-soap, as the whole quantity of lime is retained in the insoluble portion left after boiling the dried glue in water. Such an explanation accounts for the difference noticed in the effect of drying upon gelatine and common glue.

In the selection of glue, the testing of it, so as to form some estimate of its adhesive qualities, is a matter of first importance. All glue in the cake is subject to be influenced by the moistness or dryness of the atmosphere, becoming soft in damp weather and crisp in dry weather, but different kinds are differently affected, and hence it is better to purchase in dry weather, as that which is then soft is not of as good quality as that which is crisp; and it should be borne in mind also, when purchasing, that the most transparent is generally the best. It is always advisable, before purchasing, to submit to experiment a sample of the article offered. To do this, take a cake of glue, place it in a pan, and cover it with water; when, after some hours, if it be good glue, it will swell but not dissolve, while, if bad, it will partly, if not wholly, dissolve in the water. Another test is this: after being dissolved by means of heat, that glue is best which seems most cohesive, or which is capable of being drawn out into thin filaments or strings, and does not drop from the brush or glue-stick as water or oil would, but rather extends itself in threads as it falls from the brush or stick; and if the glue possesses the requisite properties, this will always be found to be the case.

During the boiling of bones for the removal of the fat, a portion of the cartilage enters into solution in the water. At ordinary bone-boiling establishments, the residual liquor, though containing more or less gelatine, is run off into the drains; but in establishments where size is made, the gelatinous liquor obtained by the prolonged boiling is drawn off by a tap from the lower part of the boiler, and is subsequently boiled down to the required consistence, either in the same or in another similar boiler, from which it is usually drawn off into cases for sale. A modification of this plan consists in crushing the bones, treating them with steam at high pressure, adding a proportion (2 per cent.) of hydrochloric acid to the semi-gelatinous mass thus formed, and reboiling. The fat separates and floats in the liquor, to be easily collected and purified by being treated first with boiling water and a very small quantity of caustic soda, next with animal charcoal, and finally filtered.

The osseous cartilage may be removed from bones by suspending them in weak nitric or hydrochloric acid (1 part acid to 9 parts water) at 50° F. (10° C.) The acid causes an effervescence, by acting on the carbonate of lime, and dissolves out the whole of that and the other earthy constituents without affecting the cartilage, which, while retaining the form of the bone, soon becomes soft and translucent. It is then washed in 2 or 3 changes of cold water, to remove all traces of acidity. It shrinks and darkens on drying, becoming hard and strong, but somewhat brittle, and losing none of its transparency. It now forms gelatine. It has been proposed to obtain gelatine from bones, &c., by means of benzine and other hydrocarbons. Sometimes it is found advisable to treat the material with lime before adding the hydrocarbon, but only rarely. After the bones have remained for a considerable time under the influence of the hydrocarbon, the fatty matters are dissolved, and the pure gelatine is found at the bottom of the vessel. The 2 products are thus easily separated, in order to be treated in the usual way, and the hydrocarbons are recovered by evaporating with steam and condensing.

German plan for preparing gelatine from bones:—The bones are exposed to the sun and air for about 6 weeks, and in dry weather are moistened several times daily with water. Quantities of 10 to 15 cwt. are put into vats, and soaked with a solution of hydrochloric acid at 4° (? Beaumé), which is drawn off when saturated, and replaced by a fresh solution, repeating till the bones are softened. These are washed in fresh water, and placed for 14 days in a solution containing a small amount of lime, then taken out and thoroughly rewashed in fresh water, and laid out upon large plates to dry in the air. The product at this stage is raw gelatine. About 300 lb. of this is laid in running water for 24 hours, which makes it soft and easily broken up; it is then left for several days exposed to the open air, after which it is put into an immense kettle with 40 gal. river water; a fire is made, and it is slowly cooked, the mixture being stirred every ½ hour, and 4 oz. alum added, which helps to liberate the fatty particles, and thus materially to purify the gelatine. After cooking for 8 to 18 hours, according to the state of the mass (which may be tested by filtering some through a linen cloth, from which it should come clear and free from all impurities), the whole is put into a vat containing 3 gal. fresh water acidulated with sulphuric acid. It is stirred, 2 qt. acetic acid are added, and the mass is left to stand for 1 hour, when it is again filtered through linen cloth, and put into wooden vessels, where it gradually attains a solid state. Before becoming thoroughly hard, it is cut by machine into thin sheets, and laid out to dry in an airy and dry spot under an awning. The very best brand of gelatine is said to be made in this way. Should it be desired to produce coloured gelatine, the following modification is needed:—On completion of the last filtration through linen cloth, a small quantity of gall is added, and then the required colouring matter. The most common colour is carmine, dissolved in *aqua ammoniæ*, and stirred into the mass. Aniline colours may also be used. The proportions are generally 1 oz. colouring matter to 4 lb. liquid gelatine, the former being first thoroughly cleaned by repeated straining through linen cloth, then added to the diluted gelatine, and the whole well mixed while warm and poured out on large frames or sheets of glass placed in a cool, dry, airy place. The sheets are taken off when dry, or just before, if they are to be stamped with patterns.

In the method of manufacture known as Rice's, the bones are placed in dilute phosphoric acid, by which the earthy matters are dissolved and removed from the cartilage, which latter can be turned into gelatine by any ordinary process. The acid is recovered from the earthy matter for re-use in the following way:—About ⅔ or more of the solution of acid phosphate of lime is submitted to the action of sulphurous or sulphuric acid, which precipitates the lime as sulphite or sulphate, either being easily removed, and leaving the acid or acid phosphate (according to the amount of acid used) in an available condition for further use on fresh bones. By extracting the phosphates originally held in the bone, this process yields an actual surplus of phosphoric acid, so that it is claimed that almost 50 per cent. can be gained on each treatment. The residues are used for manure. The cost of production is said to be greatly reduced by this plan. Phosphoric acid alone is found to be best; but it may also be used in conjunction with other acids, in such proportions that the mixture will dissolve and remove the earthy matters.

Cox's process for making "sparkling" gelatine is as follows:—The hide and skin pieces (preferably the shoulders and cheeks of ox-hides) are washed in water, chopped fine by machinery, and reduced to pulp in a mill; this pulp is pressed between rollers, mixed with water, and submitted to a heat of 150° to 212° F. (65½° to 100° C.), whereby the gelatine is extracted. To obtain a very pure quality, liquid gelatine is mixed with a small quantity of ox-blood at 160° to 170° F. (71° to 77° C.), and further heated; the albumen of the blood coagulates and forms a scum, which can be removed when the heat is withdrawn, leaving the purer liquor to settle, ready for running into coolers to harden and dry. The evaporation is conducted *in vacuo*, to reduce the temperature and duration of the operation.

Heuze obtains gelatine of good quality from even inferior sources, such as the substances obtained during the manufacture of neats'-foot oil. The gelatine from this source is very dark, and hence has only a limited sale at the low rate of about 2*d.* per lb. By digesting for 3 hours at a pressure of 3 atmospheres, pouring off the resulting ammoniacal solution of gelatine, separating the supernatant oil, and evaporating, a black friable gelatine results. Attempts to bleach this by sulphurous acid, or a sulphite and hydrochloric acid, gave unsatisfactory results. If the digestion, however, be continued for only 1 hour, and the liquid be then run off, a second digestion for an hour following with fresh water, and after pouring off the second liquor, a third for another hour, a much better result is obtained, the liquids resulting being almost perfectly decolorized by treatment with 4 per cent. of charcoal mixture, consisting of 100 parts wood charcoal, 25 parts animal charcoal. The gelatine thus obtained can be used for food, as it has no smell, and has only a slight yellow tint when seen in large masses. (*Dingler's Polytech. Jl.*)

Nelson's gelatine is extracted by steam heat from hide pieces which have been submitted to the bleaching action of sulphurous acid. The strained and purified article is spread in a thin layer on a marble slab till it partially solidifies; next it is cut up and washed to free it from all traces of the acid; again dissolved at the lowest possible temperature; and finally re-solidified and dried in thin sheets on nets.

Bone gelatine differs materially from skin gelatine, while the product of one animal may not be the same as that from another. Some gelatines—the inferior ones—dissolve at a low temperature, and others, again, set with extreme difficulty. It should be observed, says Dr. Eder, that good gelatine, when dissolved, not only colours water very slightly, but gives an almost colourless jelly. Dr. Eder suggests two practical ways of ascertaining the quality of gelatine. The first is—although it may not hold good throughout—to see how much water the material is capable of absorbing, the more water taken up the better being the gelatine. To find out this, a piece of gelatine should be accurately weighed, and then permitted to soak for 24 hours in water at 59° F. (15° C.). The examination of a series of samples in this way will soon teach something about them. Another test is to find out the weight necessary to crush a gelatine jelly. Thus, if you have half-a-dozen samples to examine, solutions are in the first place prepared, 5 *grm.* gelatine being dissolved in 45 *cc.* water. Half-a-dozen beakers or glass vessels of precisely the same diameter are obtained, and the solutions placed therein to set, at a temperature of 59° F. (15° C.). All gelatines should set at this temperature; if they do not, says Dr. Eder, they may be put on one side as unfit for photographic use. When set, there is lowered upon each jelly a little apparatus, consisting of a piece of tin shaped like a watch-glass, to the centre of which a wire is attached. The convex face touches the gelatine, and when it is weighted sufficiently it breaks through. At the upper end of the wire is a funnel, and to weight the apparatus small shot is dropped into the funnel. The weight of the apparatus should of course be in all cases the same, and this equality is soon brought about by adding shot to make up weight. The jelly which proves to be the firmest may be regarded as the best gelatine. An arrangement for steadying the wire is necessary, and this may be effected by covering the mouth of the beaker with a metallic plate having an orifice through which the wire passes. The moulded metal plate touching the gelatine need not be more than ½ in. in diameter, while such is the toughness of the gelatine in some cases that 3 lb. of shot are occasionally necessary before the apparatus tears the film. The tougher the gelatine the better it is. The better kinds of gelatine are all found to dissolve pretty well at the same temperature, but in the case of gelatine of inferior quality this dissolves in water at a very low temperature.

It is not at all necessary, remarks Dr. Ballard, that glue-works should be a nuisance to the neighbourhoods in which they are situated. As respects the materials brought into the works: the moist materials, if not to be used immediately, should be at once placed in weak or old lime-pits or tanks, and in the event of an unexpected receipt of limed fleshings or pieces beyond the manufacturer's requirements for some length of time, it would be better (if the weather permits) to dry them off for future use than to leave them in loose heaps in the yard, especially in an open yard, and not under cover. At Turney's, in Stourbridge, moist fleshings are carefully stacked for future use. Before stacking the pieces in the winter, they are washed through a milk of lime in a washing machine. They are then stacked (about 100 tons in a heap) as closely as possible, so as to exclude the air. The stacking requires care. If any hollow places are left, the pieces become bad very soon. They are best put in large heaps 6 or 8 ft. high, since their own weight presses them down, and in a few days the heap becomes quite solid. If at any time the sides or top of the heap become tainted, a layer of about 6 in. has to be cut off and re-limed. The practice adopted by some manufacturers, of preserving their fleshings immersed in lime liquor in sunken pits, is more injurious. An excess of lime has to be guarded against, since it destroys both the glue and the grease. The pieces which have been in lime for a long time yield much less than those boiled while fresh. Properly stacked pieces may without injury be preserved throughout the winter, or even for 12 months. Bevington, of Bermondsey, another very large manufacturer, agrees with Turney. He says that in the event of a glue manufacturer being from any cause overstocked with "wet" goods, and being unable to use them fast enough, the best method is, broadly, to dry them; but this course is often impracticable for several reasons, such as (*a*) because, if the weather be bad for glue, it is at the same time bad for drying fleshings; (*b*) because of the want of proper appliances and space; and (*c*) because it depreciates the value of the goods, as when once dried they cannot be used for the same purposes as wet goods, *e.g.* for size-making. The method of drying being put out of the question, the next best thing is to stack them; and if this be done properly, they are but very little injured by keeping for several months, and are no nuisance whatever. The way to do this is to place on a well-drained spot a layer of the fleshings a few inches thick, the size of the proposed stack, and then to throw over it a liberal supply of milk of lime, then put on another layer of fleshings, and treat it in the same way with milk of lime; and so on until all the goods are stacked. All this would appear to be to the interest of the manufacturer, and would certainly conduce to the comfort of his neighbours.

No good reason has been assigned for the universal practice of permitting the vapours from the boiling pans to diffuse into the atmosphere outside the sheds. There can be no more reason why this should be than it should be permitted to occur in the works of soap-boilers, trotter-boilers, &c., where methods of preventing the escape of offensive vapours from the works are in use at some establishments. Two methods of dealing with them may be suggested. One is the partial enclosure of the sheds in which the pans are situated, with the use of a fan to draw off the vapours from the interior of the building to a tall chimney-shaft; and the other is the fitting of the pan with a cover provided with such a hinged lid as shall permit of the workman stirring the contents and skimming off the fat; conjoined with a flue carrying the vapours into a fire so arranged as to produce a down-draught into the pan. Dr. Ballard observed during his visits to glue-works that the vapour from the pans was least offensive when they were heated by steam, either by jacketing the pans or by the use of open steam.

The accumulation of "scutch" in heaps in the glue-yard, and its retention there, is an instance of traditional trade slovenliness which ought at once to be put a stop to. There can be no excuse whatever for the continuance of this source of nuisance at any works. The "scutch" ought either to be put at once into hogsheads, and fastened down for removal; or, until it is removed in covered carts or barges, or in hogsheads, it should be deposited neatly in an appropriate chamber or shed, and not be allowed to remain even there above a day or two, especially in warm or muggy weather. In Freeman Wright's works, one of the best conducted, a well-ventilated shed, open on one side and provided with a raised platform, on which the scutch may be laid, and a screen to hide it from view, is found to be better than a closed-in shed or chamber. The roof and walls of such a shed, however, should be whitened outside for coolness in the summer-time, and be kept scrupulously clean and limewhited inside. At Nickols, Joppa, Leeds, and at Clark and Thackray's, Newlay, Leeds, the "scutch" is dealt with, immediately on its removal from the pans, for the extraction of the fat it contains, and the conversion of the "scutch" into a cake which is almost devoid of odour. While preventing annoyance to neighbours, the proprietors must find the process profitable. On its removal from the pans the "scutch" is thrown into a tank of water, and some sulphuric acid being added, free steam is admitted. The fat which rises is taken off, and the residue is put into coarse bags and subjected to pressure in a well-closed hydraulic press, into which more steam is thrown. The liquid matters pressed out run into a tank, where more fat rises and is collected. The cake is stored on the premises without giving offence, until it is convenient to have it removed. Such dry cake should be stored under cover.

The general untidiness and superficial filthiness of glue-yards is only another instance of slovenliness showing the conservative power which attaches to ancient tradition. It need not be so, and in the interest of the manufacturer would be better not so. All parts of the premises should be firmly and evenly paved with appropriate materials, and duly sloped to good channelling, and well drained throughout. No litter of any kind is necessary, or should be permitted. The surface should be kept constantly swept up, and washed down with water from time to time. Every scrap of gelatinous glue should be gathered into proper receptacles for return to the pans. Leakages from channels and troughs should be immediately made good. The interior and edges of the pans, and everything about them, should be kept clean and free from deposits, and tidiness of working be maintained, as it readily may be, by due regulations for the establishment. (Dr. Ballard.)

(See also Glue, under Cements, pp. 78–84; and Isinglass.)

GLYCERINE.—Glycerine is one of the constituents of fixed oils and solid fats, and though discovered by Scheele over a century ago, it has only lately come into general use. Few things in the history of chemical industry are more wonderful than the enormous development in the use of this substance, which a few years ago was thrown away as a waste product, but which now finds so many useful applications in the arts and sciences. The researches of Chevreul, which demonstrated the constitution of fats, showed that glycerine exists in nearly all neutral fats in a combined state, and small traces of it have lately been discovered uncombined in palm oil. It is formed, as Pasteur has shown, in the process of fermentation, 100 parts cane-sugar forming 3·5 parts glycerine. For practical purposes, however, glycerine is always obtained from the bye-products of candle and, quite lately, of soap-factories. Cap worked out the first process for preparing it on a commercial scale from the waste liquor of saponification of tallow by lime in the first stage of stearic acid making. Early in 1854 Tilghman produced it by pumping an emulsion of 2 parts tallow and 1 part water through a coil of pipe heated to 612° F. (322° C.), after which the emulsion separated into 2 layers, the upper one of fatty acids, and the lower of glycerine and water. Several modifications of this were afterwards patented, but the only one worked on a large scale was that of G. F. Wilson and G. Payne, dated July 24th, 1854, under which enormous quantities of glycerine have been made by Price's Candle Co. In this process, neutral fats are put into a still provided with a fine steam-worm, and a fractional condensing apparatus of large surface similar to that used in candle-making; they are then heated to between 550° and 600° F. (288° to 315° C.), and plenty of superheated steam is injected; mixed vapours of fatty acids, glycerine, and water are carried over to the condense, where the divisions nearest the still collect only fatty acids, while those farthest from it yield mixtures of fatty acids with glycerine and water in various stages of concentration. Glycerine so made can be concentrated in a vacuum-pan. Care must be taken that the temperature does not exceed 600° F. (315° C.) and that plenty of steam is present, else some of the glycerine is decomposed, and acrolein, a compound most irritating to the eyes, is formed—

Glycerine = Water + Acrolein.

$C_3H_8O_3 = 2H_2O + C_3H_4O$

Raw glycerine is also prepared from the water employed to wash the fatty acids after acidification of the neutral fats. The acid liquid is neutralized by carbonate of lime or of baryta, either of which may be added until effervescence ceases; it is then concentrated to 28° B. in an open, shallow, cast-iron pan. Of late, however, glycerine has become sufficiently valuable to cause candle manufacturers to adopt that method of preparing fatty acids which gives them the greatest yield of glycerine from neutral fats. This process, called the autoclave, as patented by De Milly on Nov. 19, 1856, is now very extensively used for glycerine-making, both on the continent of Europe and in England, and is thus conducted:—About 1 ton of fat, usually mixed tallow and palm-oil, is heated with 2 per cent. lime and $\frac{1}{3}$ the fat-volume of water, in an upright Papin's digester, under 8 atmos. pressure for 4 hours. The whole is then blown out into a tank, and the "sweet water" is run off. The lime-soap is decomposed in the usual way with sulphuric acid, and the resulting fatty acids are either pressed or acidified and distilled for stearic acid. It is then concentrated in a modification of the "Wetzel" evaporating-pan (originally introduced for sugar-boiling), constructed by Chenaillier, Paris. This *évaporateur universel*, as he terms it, which is very economical and effective, consists essentially of pairs of saucers set edge to edge upon a hollow central revolving shaft, through which steam passes to the interior of the saucers (the waste steam from a high-pressure engine will do); the lower edges of the saucers dip in a jacketed trough of the liquid to be evaporated, and when they are revolved, layers of this are brought up and speedily concentrated on their surface. It may also be worked in a vacuum. Evaporation is continued to 26° B., when the glycerine is of a brownish colour and known as "raw," in which state it is sold for many purposes. At Price's Candle Co.'s works, the further purification is conducted as follows:—The raw glycerine, sp. gr. 1·245 to 1·250, is heated in a jacketed pan with that kind of animal charcoal known as ivory black, and is then distilled; this alternate treatment is repeated as often as may be necessary. The distillation is performed with superheated steam in a copper still provided with copper fractional condensers, the still being also heated externally; the operation is performed at as low a temperature as is consistent with distillation, usually about 440° F. (227° C.). The number of distillations depends upon the quality of the raw glycerine and the purity of the product demanded. Of the 6 runs, Nos. 1, 2, and 3 usually give pure glycerine, while the dilute condense-products from Nos. 4, 5, and 6 are generally returned to the still, though occasionally concentrated in an *évaporateur universel*, or in a vacuum-pan. Some stills hold as much as 3 tons, but they are usually smaller, and in all cases the process is conducted very slowly. A form of still and condenser much used on the continent of Europe is outlined in Fig. 13. External heat and injected superheated steam are used to effect distillation. The still A has an unusually large head B, and the goose-neck C is provided with a catch-box D, in case the still-contents should, as sometimes happens, boil over; the fractional condensers E are upright cylinders with longitudinal partitions F running nearly their whole length; the condensed products run out through G into receptacles H. The whole apparatus is of iron, and usually made to distil $\frac{1}{2}$ ton at a time;

in some cases the process is conducted continuously, with a properly-arranged feed.

Enormous quantities of glycerine are run to waste in the spent lyes of the soapmaker. One of the earliest attempts to extract it was a patent by H. Reynolds, June 10, 1858, for concentrating the spent lyes, and distilling off the glycerine by superheated steam between 380° and 400° F. ($193\frac{1}{3}$° to $204\frac{1}{2}$° C.); the large quantity of sodium salts, especially sodium chloride, was found, however, to be an almost insuperable difficulty. On March 31, 1879, a patent was taken out by C. Thomas, W. J. Fuller, and S. A. King, of Broad Plain Soap Works, Bristol, by which process the first successful production of crude glycerine from spent soap-lyes was introduced into commerce, and several tons per week are now manufactured. The specification states that they "evaporate the spent or partially spent lyes until the boiling-point of the liquid rapidly rises, when nearly all the salts that can be thrown down by simple evaporation are deposited in the pan. The resulting liquor is chiefly composed of raw or impure glycerine. This we draw off into a second pan, and boil it with excess of fatty acid, which, readily combining with some of the salts in solution, separates them from the liquor, and at the same time removes from it the fine crystals of salt formed during this operation. After this treatment, we skim off the saponified fatty matter, allow the liquid to cool, and filter it to remove the gelatinous, albuminous, and other impurities. The clear liquid may then be refined, distilled, or concentrated, as desired."

In his address to the first general meeting of the Society of Chemical Industry, the president called attention to the waste of glycerine in the soap trade, and pointed out that, in view of the growing demand for this substance for the manufacture of explosives, &c., its then price was 120*l.* per ton. Already at that time soapmakers had begun to turn their attention to the more complete recovery of the glycerine contained in the spent lyes, and since then the subject has been still further pursued. These lyes contain water, glycerine, common salt, sulphate of sodium, a small quantity of caustic soda and sodium carbonate, and small amounts of albuminous, resinous, and soapy matters. To illustrate their general composition when concentrated to a certain degree (which is easily attained in practice), Kingzett states the composition of a sample recently examined by him. It showed a specific gravity of 1·236, the gallon being made up as follows:—

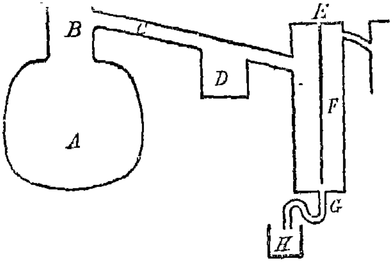


Fig. 13.

Water	7·53 lb.
Glycerine	2·04 lb.
Salts	2·78 lb.
	12·35 lb.

Analysis of the salts as deposited from the lyes upon concentration:—

NaCl	78·12
Na_2SO_4	8·61
Insoluble inorganic matter...	0·22
Glycerine and organic matter	3·55
Water	7·50
Alkali (calculated entirely as carbonate of sodium ......)	2·61
	100·61

the excess over 100 being caused by calculating all the alkali present as Na_2CO_3, the fact being that some of it was in the caustic condition.

A study of the various patents that

have been granted recently in connection with the recovery of glycerine is thus summarized by Kingzett:—

Constant Victor Clolus (specification No. 681 of 1881) neutralizes soap lyes with hydrochloric acid, and evaporates the settled liquor till it registers 32° B. Heated air is then blown through to remove the rest of the water, the salts deposited during both stages being fished out and treated in a turbine. The final product may be finished by drying *in vacuo*. The crude glycerine thus obtained is said to contain but little salt, but the exact amount is not stated. It may be distilled in order to purify it. So far he fails to detect anything of an original character in this proceeding. Instead, however, of neutralizing the soap lyes with hydrochloric acid, the patentee may use carbonic anhydride, so that when evaporation has been carried to 25° B., after further exposure to carbonic anhydride, bicarbonate of sodium (being only slightly soluble in a glycerine solution of salt) is precipitated upon cooling. Another mode of freeing his crude glycerine from salt consists in treating it with excess of hydrochloric acid of 22° B., or in the form of gas. The solubility of the salt is said to be thus diminished, and in consequence more of it can be removed. The excess of hydrochloric acid is subsequently got rid of by a current of air, or by an excess of plumbic oxide.

Benno, Jaffé, and Darmstaedter (specification No. 1562 of 1881) employ sulphate instead of chloride of sodium for salting out the soap. They then neutralize the spent lyes with sulphuric acid, filter, evaporate, and thus get only sulphate of sodium separated. They say the sulphate is removed more easily than the chloride, and hence the value of this method seems to turn on whether the increased ease of removing the salts more than atones for the increased cost of material for salting out, because the only comparable difficulty in removing the chloride is one of cost.

George Payne (specification No. 2816 of 1881) neutralizes the lyes with an acid, allows any precipitate to settle, and then adds a 10 per cent. (by weight) solution of tannin or tannic acid, until albuminous matter is no longer precipitated. The filtered liquor is concentrated by heated air or superheated steam, or direct by fire. He thus gets, he says, a crude solution of glycerine containing about 10 per cent. salts, which may be more easily refined than any other crude glycerine. In connection with this patent, Kingzett regards it as pertinent to ask whether the excess of tannin introduced is not as objectionable as the matter thereby removed.

C. Thomas and A. Domeier (specification No. 2462 of 1881) concentrate the lyes and add an excess of acid until there is present about 1 to 1½ per cent. free acid. This is to decompose any soap, eliminate resinous matters, and to so act on other matters that, when neutralized by alkali later on, they are precipitated. After this neutralization and settlement, the lyes are further concentrated, and the crude glycerine is extracted with about 33 per cent. of coal-tar oil or petroleum, or bisulphide of carbon, or amylic alcohol, or ether, or other menstruum in which the glycerine is insoluble, in order to remove any soluble matters which may be disagreeable to the smell or taste. After extraction, the glycerine is subjected to hot air or steam in order to get rid of traces of the solvent employed, and may then be used for commercial purposes, or further purified by distillation. They also describe an apparatus designed for the concentration of thin lyes, in which the liquor slowly descends a tower fitted with alternately-inclined shelves, and in which it encounters a current of hot air, much in the same manner as Leather proposed to make bleaching-powder, viz., by causing lime to encounter an ascending current of chlorine gas in its descent down a tower fitted with a continuous spiral shelf.

J. Weineck (specification No. 1289 of 1881) avoids the use of both chloride and sulphate of sodium in soapmaking as follows:—He exposes fats in a cylindrical wrought-iron vessel, fitted with a stirring gear, and provided with a jacket which is filled with hot water. At 113° F. (45° C.), the tallow (when that fat is used) melts, and then 20 per cent. of a 2 per cent. solution of soap at the same temperature is added to the fats, stirring meanwhile. When the mass is perfectly emulsified, caustic lye of the same temperature is added. When well mixed, the temperature is raised to about 194° F. (90° C.), and the stirrer is kept at work until saponification is completed. After some hours, the spent lye is let off, and registers 5° to 10° B. Operating thus, he claims to utilize some chemical heat evolved in the action of the lye upon the emulsified fats, and by saponifying the fats in this globular state he says he saves fuel, time, labour, cost on plant, and, above all, obtains lyes free from any large amount of salts. But even in this process, assuming it works otherwise satisfactorily, it would appear that the alkaline lye must be neutralized with an acid before concentration, otherwise the glycerine would suffer decomposition. Perhaps in such a case, however, carbonic anhydride could be profitably employed.

The most curious specification is that (No. 2176 of 1881) of P. J. Baptiste Depoully and Léon Droux, of Paris. These gentlemen neutralize the spent lyes with any acid, filter, evaporate, remove the deposited salts, and heat the mother-liquor in contact with oleic acid or other fatty acids at a temperature of 338° to 347° F. (170° to 175° C.) In this way they reproduce fats which are washed, and subsequently decomposed by means of lime, or by superheated steam, with or without the aid of sulphuric acid. When lime is employed, the soap thus produced is afterwards decomposed by the agency of an acid; or, instead of using free fatty acids, the patentees employ neutral fats and oils in their process, thus giving rise to the formation of diacid and monacid glycerides. In brief, the whole of their proposals are based upon the well-known classical investigation of Berthelot, but it is not easy to see in what precise manner they can be economically carried out in commercial practice.

Reviewing these various specifications, the different processes described therein are designed to effect the following objects:—

1. To remove or destroy albuminous and resinous matters, together with any residual soap contained in spent soap-lyes.

2. To facilitate the removal of the salt, either by employing means to diminish the solubility of chloride of sodium, in cases where that substance is used, or to substitute for it another, which may be more readily and profitably removed.

3. To economise the cost of concentrating the purified lyes to that point at which the glycerine may be at once employed for certain purposes in its then crude condition, or still further purified by distillation.

Kingzett very much questions whether the alkali utilized by the carbonic anhydride process would pay for the cost of the gas necessary to be employed, except, perhaps, in conjunction with Weineck's process; and he equally doubts whether the cost and trouble of increasing the insolubility of chloride of sodium in glycerine liquors, by the employment of hydrochloric acid, would even be balanced by the effect produced. Speaking generally, therefore, and after giving a considerable amount of practical attention to this subject, the soapmaker who wishes to recover the glycerine from spent lyes cannot do better at present, it would appear to Kingzett, than proceed to evaporate the water from the neutralized liquor in the most economical manner available, with the dual object of getting rid, by deposition and crystallization, of as much salts as possible, and of preparing the crude glycerine for distillation, and surely he can do all this without the use or infringement of any patented process—indeed, it is being done on a large scale. But there is another way of dealing with the production of glycerine already known and practised, and which will, Kingzett feels sure, be much more widely adopted in the course of time. At present the soapmaker saponifies neutral fats and oils with caustic lye, and then, at an expensive rate, seeks to recover the glycerine left in the lees; but, theoretically speaking, he would be better advised to decompose the fats and oils, in the first place, in the manner that is practised by the candlemaker, viz., by the agency of superheated steam, with or without the assistance of sulphuric acid or lime, using the fatty acids for saponification with alkali, and obtaining comparatively pure glycerine in this direct manner. The practical objection to this procedure is that the existing plant of soapmakers is not adapted to the process, and, moreover, they cannot produce such good-coloured soaps from the fatty acids as result from the direct saponification of fats. But this is largely a sentimental objection, the soap being really equal in quality, and, so far as the objection is sound, Kingzett is confident that at the right time it will be overcome. (*Jl. Soc. Chem. Ind.*)

It may be remarked that Clolus's process has been in successful operation for some time at his works at Billancourt, near Paris, while additional works have been erected at Marseilles, Runcorn, and Glasgow.

H. Fleming, of Kalk, near Cologne (German patent No. 13,953 of 1880), proposes to subject the soap lyes to dialysis. In an article in the *Seifenfabricant*, he points out that 4 works in the town of Neuwied alone run to waste about 1500 tons of lye per annum, which contain 75 tons of glycerine, worth about 7500*l.* Lyes contain between ·92 and 7·8 per cent. of glycerine. Before being able to recover the latter, it is necessary to remove the sodium chloride, which is best done by osmosis. The lyes are first evaporated by steam until the liquor contains at least 20 per cent. of glycerine. It is then neutralized with sulphuric acid. The quantity of the acid required varies much, as the liquors contain from 1·9 to 19·9 per cent. of sodium carbonate. Where soda ash has been used instead of sodium chloride for the purpose of salting out, as much as 31 per cent. of alkali has been found in the lye after evaporation. It is advisable to use a slight excess of sulphuric acid, afterwards to let the liquors stand to crystallize, and then to neutralize them with lime; after settling, they are further evaporated. They should now contain no less than 40 per cent. of glycerine, but may contain as much as 66 per cent. The specific gravity is about 1·28; the ashes about 13 to 16 per cent. At this stage the cost of 1 lb. of glycerine is about 1½*d.* The liquor is now ready for osmosis, by which process the ashes it contains are so far reduced that after further evaporation it can be distilled either by itself or with crude glycerine from stearine works. The loss on distilling is small, and the product pure enough for dynamite works. When evaporated to 1·26 specific gravity, and therefore free from water, it contains no sodium chloride. The lyes do not attack the parchment paper, as they contain no lime compounds, the paper having been found in good condition after 6 months' usage. The patentee calculates the cost of 1 lb. of 60 per cent. glycerine at 2¾*d.* The water of osmosis contains a considerable quantity of glycerine. In one experiment, 1400 lb. of the water gave 23 lb. liquor, containing 16 lb. glycerine, at a cost of about 2¾*d.* per lb. This product, contaminated with salt, and therefore not as pure as that obtained in stearine works, was still found as pure as a common Dutch glycerine of 63 per cent. which cost 1*s.* per lb. In the patentee's opinion, the proposal of using only fatty acids in soapmaking, and of decomposing the fats for that purpose in an autoclave, promises but little success.

In a subsequent patent, Fleming obviates the diffusion of the glycerine by replacing the ordinary parchment paper by a guttapercha membrane, which is proof against the passage of glycerine.

O'Farrell evaporates the soap lyes to the saturation point of sodium chloride, and uses it again to precipitate fresh soap. This is repeated till the lye is very rich in glycerine. The solution is next evaporated till all the salt crystallizes out, and is then distilled *in vacuo*, with a steam jet at about 392° F, (200° C.). The distillate is heated a second time with low surface-heat only, to separate the water as steam.

Dr. Versman, of New Charlton, separates a large percentage of the salts in soap lyes by simply boiling down the soap-lye and raking out the salts as they become insoluble; he then allows the concentrated solution to cool, after which carbonic acid gas is passed through it until the whole of the carbonate and caustic soda is converted into bicarbonate of soda, which is much less soluble in glycerine than either the carbonate of soda or the caustic soda, and may readily be removed by filtration or other convenient means. The liquid from which the bicarbonate of soda has been removed is rich in glycerine, but it still retains sensible quantities of chloride of sodium and other salts, the presence of which may act injuriously in the subsequent application of the glycerine to certain purposes. These salts the patentee separates by submitting the liquid, either hot or cold, to the process of osmosis in an apparatus known as the "osmogene," such as is used in the separation of saline compounds from solutions of beet-root sugar; by this process nearly all the salts are separated from the glycerine; but as the latter becomes diluted with water, it is concentrated by evaporation, when it will be ready for the market as crude glycerine. Instead of commencing the treatment by boiling down the lye, carbonic acid gas may be passed through the original soap-lye, or, if preferred, the use of carbonic acid gas may be dispensed with; but the patentee finds the most convenient and economical way is to first reduce the bulk of the liquid by boiling down, so as to separate large quantities of the salts, and then to treat the liquid with carbonic acid; the subsequent treatment in the osmogene is essential in all cases. This osmogene is a modification of Graham's dialyser, and consists of 40 or more cells formed by sheets of parchment paper laid flat and connected at the edges all round, the space between each pair of sheets being fully ½ in. Each sheet is supported by a cross piece of wood and a network of string, and the whole affair is about 4 ft. long by 3 ft. high. Water is sent through alternate spaces, and the substance from which the salts are to be extracted through the others, the water by osmosis carrying off the salts and leaving a small quantity of itself in the glycerine or other substance.

F. H. T. Allen's process is as follows: First, if necessary, he neutralizes the soap lye with any ordinary mineral acid, and agitates; after settling, he adds a solution of alum, or solid chloride of lime (bleaching-powder), or crude pyroligneous acid, and stirs thoroughly; or evaporates to nearly salting point, before adding any of the substances named above. He allows the precipitate to fall, leaving a clear liquor, and after settling, draws off the clear upper liquor, and evaporates to concentration in pans (in which the heat is only applied at the sides). Finally, he distils this liquor in a glycerine retort, having a current of superheated steam within, and provided with an exit pipe at the bottom, which carries off the precipitated salt as it accumulates.

J. P. Battershall, New York, heats the liquors with steam, neutralizes with sulphuric acid, and concentrates to $\frac{1}{10}$ their original bulk. A slight excess of acid is added, if necessary, to separate the resin and fat. Carbonate of lime is then added to again neutralize the liquor; the latter is cooled, and the liquor separated from the crystallized salts in a centrifugal machine. The liquid is then distilled to purify the glycerine from the residual salts. Alcohols can be used instead of distillation, the precipitated salts (insoluble in alcohol), filtered or fished out, and the glycerine and alcohol separated by distillation. The crude glycerine can then be decolorized by filtering through bone-black.

Although evaporation and distillation are the usual methods of purifying glycerine, the action of cold upon more or less dilute glycerine is sometimes employed in conjunction with them, especially by Sarg, at Vienna. When an aqueous solution of glycerine partially freezes, the frozen mass contains more water than the remaining liquid; hence some amount of concentration may be thus effected. The following table gives the freezing-points of such mixtures:—

Glycerine, per cent.	Sp. Gr.	Freezes.	Glycerine, per cent.	Sp. Gr.	Freezes.
10	1·024	− 1° C.	60	1·159	Below − 35° C.
20	1·051	− 2°·5	70	1·179	
30	1·075	− 6°	80	1·220	
40	1·105	− 17°·5	90	1·232	
50	1·127	− 31°·3	94	1·241	

Another authority gives:—

	sp. gr.	sp. gr.	sp. gr.	sp. gr.
Glycerine .	10° B.	12° B.	14° B.	16° B.
Melting-point	9° C.	13° C.	18° C.	21° C.

In January 1867, some glycerine sent in tin cans from Germany to England froze into pea-sized octahedral crystals; these while melting had a constant temperature of 45° F. (7°·2 C.), but would not freeze again even when cooled to 0° F. (−18° C.). According to Werner, commercial glycerine will freeze more readily if chlorine gas be passed into it. In purifying glycerine by cold, the whole mass is cooled to nearly 32° F. (0° C.), and some crystals of solid glycerine are added; almost the whole mass solidifies on agitation, and a centrifugal is used to separate the solid from the liquid parts. Treated in this way, glycerine at 28° B. yields crystals which, when melted, are 30°·8 B.

Pure glycerine is a viscid, colourless, and transparent liquid, with an intensely sweet taste, soluble in water in all proportions, in alcohol, chloroform, and carbon bisulphide, but not in ether; its sp. gr. is 1·267; it solidifies at − 32° F. (− 40° C.) to an amorphous mass. When distilled, it decomposes, unless steam be present; hence its boiling-point cannot be accurately determined at atmospheric pressure. According to Bolas, at 12·5 mm. pressure it boils at 355° F. (179°·5 C.), and at 50 mm. at 410° F. (210° C.); while Heninger gives 354° F. (179° C.) as its boiling-point under 20 mm.

It burns with a clear flame like oil, if there be free access of air and a high temperature for kindling it.

Commercial glycerine is liable to contain various impurities, arising from its mode of preparation; also certain adulterants, of which cane-sugar and glucose are the chief. Glucose may be detected by the brown colour formed when the suspected glycerine is boiled with caustic soda; cane-sugar is shown by its deposition when the glycerine is agitated with chloroform, or, more certainly, by a polarising saccharimeter, since glycerine has no rotatory action on the plane of polarisation. Lead is detected by sulphuretted hydrogen; lime, by the addition of alcohol and sulphuric acid, a white precipitate of calcium sulphate being formed; butyric and formic acids, by the characteristic smell of their ethers, produced by boiling the suspected glycerine with alcohol and strong sulphuric acid; oxalic acid by the addition of calcium chloride and ammonia; sodium chloride, by the addition of silver nitrate, which should give no precipitate with pure glycerine after 24 hours' standing. A rough and ready test for impurities generally is to agitate the glycerine with an equal bulk of chloroform, when they collect in the intermediate layer.

Under the title of "Adulteration of

Glycerine" F. Jean contributes an article to the *Journal de Pharmacie d'Alsace-Lorraine*, in which he considers not merely adulterations intentionally added, but impurities due to carelessness in its manufacture or purification. Among them are oxide of lead, lime, and butyric acid. French perfumers and manufacturers of cosmetics test their glycerine with nitrate of silver. If no turbidity or change of colour takes place in 24 hours, it is considered good. The chloroform test for glycerine consists in mixing equal volumes of chloroform and glycerine, shaking thoroughly, and then letting them stand. The upper stratum is pure glycerine, while the lower one is chloroform containing all the impurities. If there were no impurities in the glycerine, the chloroform remains unchanged, otherwise there will be a turbid layer just beneath the glycerine. On adding a few drops of dilute sulphuric acid to a mixture of equal parts of glycerine and distilled water, and then a little alcohol, the presence of lime or lead will be shown by a white precipitate. The latter is reorganised by sulphydric acid, which turns the precipitate black. Butyric acid is detected by mixing the glycerine with absolute alcohol and sulphuric acid of 66° B. On gently heating the mixture, the butyric ether is easily recognised by its agreeable odour. Formic and oxalic acids are also found in glycerine, impurities which are of special importance to pharmacists. They are detected as follows:—Equal volumes of glycerine and sulphuric acid, sp. gr. 1·83, are mixed together. Pure glycerine does not give off any carbonic oxide gas, but if either of the acids mentioned is present, an evolution of that gas will be observed. To decide whether both acids are present, and if not which one, some alcohol of 40° B. and one drop of sulphuric acid are added, and then gently heated. Formic acid (used in making essence of peaches) will be recognised at once by its characteristic odour, and proves the presence of formic acid. To another sample of the glycerine add a little solution of chloride of calcium (free from carbonate), when it will give a precipitate of oxalate of lime, if oxalic acid is present. Sugar, glucose, dextrine, and gum are often used as intentional adulterations of glycerine, and are tested for as follows: The glycerine is mixed with 150 or 200 drops distilled water, and ½ gr. molybdate of ammonia is added, and one drop of pure nitric acid. It is boiled about 30 seconds. If sugar or dextrine is present, the mixture will be blue. Glycerine adulterated with loaf sugar or syrup acquires a brownish black colour when boiled with sulphuric acid. Glucose is detected by boiling it with caustic soda, which turns it brown. If detected qualitatively, the quantity may be estimated by the following method: 5 grm. glycerine are weighed out and mixed with 5 cc. distilled water. It is boiled in a little flask, with Barreswil's alkaline solution of tartrate of copper. The suboxide of copper is precipitated, and the precipitate is dissolved again in hydrochloric acid. An excess of ammonia is added, and it is poured into a vessel containing an excess of nitrate of silver. A precipitate of metallic silver is formed and filtered out. It is washed with warm water and ammonia, calcined at a red heat, and weighed; 109·6 parts metallic silver represent 100 of glucose. If cane sugar or dextrine is found, it is boiled for ½ hour with acidified water to convert these substances into glucose. If none of these impurities is present, the amount of water is found by Vogel's well-known method.

Dr. Odling mentions the curious fact that hydrocyanic (prussic) acid is an excellent test for the purity of glycerine, the slightest admixture of any foreign substance causing the glycerine to turn yellow in a short time if a little hydrocyanic acid be stirred into the liquid.

According to Klever, 100 parts glycerine will dissolve:

	Parts.
Acid arsenious	20·00
,, arsenic	20·00
,, benzoic	10 to 20·00
,, boracic	10·00

	Parts.
Acid oxalic	15·00
„ tannic	50·00
Alum	40·00
Ammonia carbonate	20·00
„ muriate	20·00
Antimony tartrate	5·50
Atropine	3·00
„ sulphate	33·00
Barium chloride	10·00
Borax	60·00
Brucine	2·25
Cinchona	0·50
„ sulphate	6·70
Copper acetate	10·00
„ sulphate	30·00
Iron lactate	16·00
„ sulphate	25·00
Iodine	1·90
Lead acetate	20·00
Mercury bichloride	7·50
„ bicyanide	27·00
„ arseniate	50·00
Potash chlorate	3·50
„ and iron tartrate	8·00
Potassium bromide	25·00
„ cyanide	32·00
„ iodide	40·00
Morphine	0·45
„ acetate	20·00
„ muriate	20·00
Soda arseniate	50·00
„ bicarbonate	8·00
„ carbonate	98·00
Phosphorus	0·20
Sulphur	0·10
Strychnine	4·00
„ nitrate	0·25
„ sulphate	22·40
Veratrine	1·00
Zinc chloride	50·00
„ iodide	40·00
„ sulphate	35·00

Glycerine is particularly valuable as a solvent for gum-arabic, as also in paste. Glue, by continued digestion, is soluble in glycerine, gelatinising on cooling. Glycerine dissolves aniline violet, alizarine, and alcoholic madder extract. A solution of aniline colour in glycerine is often used for stamping with rubber hand stamps. Glycerine is employed to extract the perfume from flowers, and the aromatic principle of red peppers. Sulphate of quinine dissolves in 10 parts glycerine when hot, but when cold separates in clots, which, when triturated with the supernatant liquid, gives it the consistence of a cerate, very useful for frictions and embrocations. Warm glycerine (50 parts) will hold in solution when cold 1 of salicylic acid; 300 parts water may be added without causing precipitation.

Glycerine is daily becoming of greater importance to the textile manufacturer. As a lubricant of machinery it is invaluable, and in many instances preferable to oil or greases, especially where such machinery is exposed to the action of the air or great alterations of temperature; it neither thickens, freezes, nor gets rancid, thus keeping the rubbing parts constantly lubricated, which cannot be done by substances which desiccate, and retain the dust flying about in the air, thus clogging the bearings. For lubricating purposes, the pure glycerine may be mixed with half its quantity of olive oil. Glycerine does not attack metals like many oils which have been treated with acids.

Glycerine is not of inferior importance in weaving; by its use the size will never tend to smell badly, and a hand-loom weaver may work at all times, either with an open window or with a large fire in his room; his yarn will always be in a good condition, and not become brittle, nor will cloth sized with a compound containing glycerine ever mildew or rot; and the following mixture is therefore recommended for this size, viz., 10 lb. farina, 24 lb. glycerine of 28° B., 2 lb. sulphate of alumina, and 6 qt. water.

Glycerine is not only a good solvent for aniline colours, but it tends likewise to preserve for a long time the compositions of albumen, of casein, and solutions of gum used in finishing; it keeps them in a liquid state, and prevents them from putrefying through its antiseptic qualities.

It is also of great use for printing woollen or worsted goods, because the colours printed with it are thus, before the steaming, kept in a humid state, while in cotton printing it accelerates and favours the oxidization of the mordants before the dyeing. In general, for finishing colours and mordants, 8 oz. suffice for 1 gal. For dyeing, printing, and finishing, it is not necessary that the glycerine be perfectly white, for when of a pale yellow it will give the same results, while its price will be much lower. Only for very delicate colours, such as ultramarine and others, it is advisable to take purified glycerine. Glycerine of 26° to 28° B. suffices, when exempt from acid or alkali—*i.e.* when it turns litmus paper neither red nor blue; glycerine of 30° is seldom used. It must not contain any lime, if it is to be used for colours. To test it for this, a little of the suspected glycerine should be poured into a test-tube, then mixed with half its quantity of water, and a few drops of a solution of oxalic acid is added. If the solution contains lime, it is clearly shown by the white precipitate which will deposit after a little rest.

Glycerine is sometimes adulterated with grape sugar, common syrup, or similar substances, especially when it has not been purified, and is still of a brownish colour; it loses in such a case a good deal of its aroma, but retains its moderate degree of fluidity, and the buyer is easily deceived.

In Dresden, glycerine is generally used in place of water in gas-meters; after it has been so used for some years it becomes foul and requires purification. The fluid is first heated for 12 hours to 122° to 146° F. (50° to 60° C.), and next to 266° to 302° F. (130° to 150° C.), in order to eliminate water, ammoniacal compounds, and other volatile impurities; the glycerine is next filtered over granulated animal charcoal. Some 300 to 400 cwt. of glycerine are annually purified in this manner at Dresden. It is said that the cloudiness produced on glass by water in a vaporous state (dew, breath, steam), may be prevented by wiping the surface with a rag moistened with glycerine. Glycerine coloured with aniline has been used in barometer tubes at Kew.

GUT.—"Gut-spinning" is the twisting of prepared gut into cord of various diameter for various purposes—*i.e.* for ordinary catgut, for use in machinery, and for fiddle-strings. Hence in d or ferent establishments articles of ecoal ferent fineness and coarseness are t the pared, from the most delicate should string to a thick catgut cable. rough times all these varieties are made i boxes same establishment. The first e pro- tion, however, in every instance i from "gut-scraping." For sausage-skinen the manipulation of the gut ceases hel serve

The gut used for the above pu offen- is the small intestine of sheep an to the It is said that the sheep's smallcovered tine measures 25 to 30 yd., ancapable hog's about 20 yd. The guts are ment lected from butchers, and in some establishments they are received from the country, or, packed with salt in barrels, from Ireland. In some establishments dried guts previously scraped are received from abroad for further manipulation. For fine purposes, such as the making of fiddle-strings, only the best and freshest guts from the butcher can be used; but for coarser purposes, their condition as to freshness is less material, and sometimes they arrive at the works in an offensive condition. The scraping is more easily effected when the gut is not quite fresh.

The first operation in gut-scraping is to get rid of the contents of the gut. For this purpose, it is thrown into a tub of water, by which a man sits, and passes the gut between his fingers into another tub of water, pressing the contents along the cavity as he proceeds. In some works, water from a tap over which an end of the gut is slipped is run through the gut. This is repeated several times until the gut is quite clean. In one case the guts are then placed in brine for 8 or 10 days, and then for 3 or 4 days in cold water.

The process of scraping is, in the larger establishments, performed by women. A bench or table is provided, at which a woman sits and scrapes the gut with a wedge-shaped piece of wood as she passes it along the table before her. In some places the back of a knife is used for this purpose. By this process all the interior softer parts are tached and pass along the gut to the l, where they are discharged, the toneum of the gut, and probably a of the muscular layer, being alone It is again thrown into water. further treatment depends upon se to which the scraped gut is to plied. When it is to be used for ge-skins, the scraped guts are packed in barrels with salt. s are intended for making catgut le-strings are treated further. ome establishments, scraped guts ried for exportation. They are ched over frames, dried in a chamartificially heated, and then tied up n bundles. When dried guts are received, they are soaked in water to prepare them for spinning.

For making ordinary catgut, no further preparation is needed than sewing together lengths of scraped gut with a needle and thread. They then go to be spun by means of an ordinary spinning-wheel. The number of strands of gut spun into a cord varies with the thickness of catgut required. Catgut ½ in. thick will have as many as 700 strands of gut in it. When a length of catgut has been spun, it is dried by stretching it over pegs and exposing it (protected in some way from the weather) in the open air. Before drying, however, it is customary to bleach it by stretching it upon a frame and putting it for about 3 days into a chamber where it is exposed to the action of the fumes of burning sulphur.

The preparation of fiddle-strings is a very delicate operation, and for the finest violin strings requires the utmost care. The best scraped guts alone are used, and such as have any flaw in them are rejected. Each gut is treated separately. It is put into a clean earthenware pan containing a weak alkaline solution, and this solution is changed (a fresh pan being used each time) twice a day for 7 or 8 days, and each time the gut is transferred it is stripped through a ring formed by bending a strip of copper, or through a perforated brass thimble, the thumb being pressed upon the gut as it is passed through. After this treatment it is ready for spinning. The first strings of violins are made by twisting together 3, or better 4, such prepared guts. (Dr. Ballard.)

The external membrane removed in the scraping process is called *filandre* by the French, and is employed for the cords of battledores and rackets, as well as for sewing together the ends of intestines. The alkaline solution for treating the fiddle-string gut is commonly made of 4 oz. caustic potash and 4 oz. carbonate of potash in 3 to 4 gal. water. The so-called "bleaching" with sulphur fumes is intended rather as a preventive of putrefaction. The twisted and smoothed cords are often finally dried for an hour in a room heated to 180° to 200° F. (82° to 93° C.). Hatters' cords, for bowstrings used in one of the stages of felt-hat making, are made from the longest and largest sheep-gut, 4 to 12 strands being used, and the ordinary length being 12 ft. In France very strong cord is prepared from the intestines of horses, asses, and mules. The scraped gut is divided into 4 equal parts by drawing it over a fixed knob with 4 sharp edges; 4 to 8 of these strips are tied at the end with packthread, twisted together, and polished with dog-skin. This cord is used as a substitute for leather belting on light machinery. About three-fourths of all the gut used in Europe is said to come from Italy. The superiority of the Italian article is ascribed to the leanness of the sheep, so that probably emaciated carcases yield the best strings. (Spons' *Encyclopædia.*)

The putrefactive odours attending this business are a frequent cause of complaint. In no case did Dr. Ballard find a deodorant applied to such raw gut as comes in an offensive condition, nor to such as had been left to soak until offensive, for the convenience of ready scraping, nor even to the offensive refuse of the process, for the purpose of destroying their bad odour. But that the use of a chemical agent for the prevention of putrefaction in the fresh guts is admissible, and even successfully practised in some establishments in France, is shown by the following translated abstract from De Freycinet's report on trade sanitation:—

"The cleansing or separation of the peritoneal membrane, a portion only of which has been removed by the "ungreasing" at the slaughter-house, is ordinarily performed at the conclusion of a putrid fermentation that constitutes one of the most repulsive details of this industry. This maceration, whose duration varies from 8 days to a month, according to the season, is intended to partly decompose the mucus and render it less adherent, so that the workmen may be able to detach it without risk of injuring the quality of the gut. Some manufacturers are commencing to adopt Labarraque's process, consisting in immersing the intestines in a solution of sodium chloride, which hinders all putrid fermentation. A few hours then suffice for the retting or maceration of the gut." He adds that at one works the Conseil d'Hygiène publique ordered the use of "sodium chloride at 12° to 13° B., in the proportion of about 3½ lb. in 2 or 3 buckets of water per vat containing the guts of 50 oxen."

At Coulson's sausage factory at Cambridge, Dr. Ballard found it was the practice to immerse the fresh guts for a few days before scraping them in a weak solution of chloralum; this treatment avoids noxious odours, does not injure the gut, and does not in any way interfere with the scraping. Dr. Ballard lays down the following rules as essential for carrying on this trade without creating a nuisance:—(1) A building specially erected or carefully adapted to the peculiarities of the trade, sufficiently spacious, and situated as far as practicable in a locality not closely built in. The chamber where any of the more offensive parts of the trade are conducted should have no direct communication with other rooms. It should be lighted either from the sides or roof with windows incapable of being opened, and ventilation should be provided for independently. It appears to him that the best mode of managing this would be to arrange for the drawing off of the foul air of the chamber continuously, and conducting it through a fire, or first through a screen of wood charcoal and then through a fire, and that the air for the supply of the room should be drawn from the outside through screens, or properly arranged boxes containing wood charcoal, duly protected from wet and damp, and from time to time renewed, which, when the room was shut up at night would serve to arrest the passage outwards of offensive effluvia. The inner walls, to the height of about 6 ft., should be covered with some impervious material capable of being washed, such as smooth cement or sheet zinc. (2) The floor should be paved with an impervious paving, preferably jointless, and it should be properly sloped to a duly trapped drain gully. (3) There should be an unrestricted supply of water. (4) Scrupulous cleanliness should be observed in the conduct of the business. The floor should be kept constantly sprinkled with some deodorant solution, such as of carbolic acid or chloride of lime; no unnecessary litter should be allowed, and any that may be made should be frequently swept up, and, together with refuse matters and scrapings, should be deposited, with the addition of a deodorant, in appropriate vessels made of some impervious material, such as galvanised iron, and covered with covers of like material when not required to be open for use. At the close of each day's work, the floor and walls, to the height of the impervious portion, should be washed down with water containing some deodorant, and all tubs, tables, benches, and utensils that have been in use should be similarly cleansed. The inner walls and ceilings should be periodically lime-whited. (5) All undried gut brought upon the premises should be brought in closed impervious vessels, which should not be opened except in the chamber where they are to be manipulated, and all refuse matters should be removed from the premises daily in the closed vessels in which they are deposited. Any gut which arrives in an offensive condition should at once be placed in a deodorant solution; and some antiseptic solution should (as appears to be practicable) be used for the soaking even of fresh guts on their first arrival. (6) Great care should be taken in dealing with the refuse matters after removal from the premises. If deposited anywhere upon land, the matters should at once be covered over with a layer of fresh earth. At Calne, where the nuisance from the deposit of refuse in farm premises was at one time intolerable at a distance of several hundred yards, the nuisance has, without altering the position of the deposit, been obviated. A wall of straw litter is made, enclosing a space within which the refuse is thrown, and the offensive matter is immediately covered up with dry earth and ashes: this building up of the wall and deposit of refuse and earth is continued until a sufficient mound is raised. When it becomes necessary to remove this as manure, it is removed inoffensively. Such a stack as this should, however, be protected from the rain.

Silkworm Gut.—This substance, also called Florence gut, or simply Florence, is the fine strong fibre universally employed by anglers for attaching their hooks. Its preparation is thus described by Mrs. Whitby:— There are some silkworms which come to maturity, turn yellow, but not clear, yet show no disposition to rise on the manello. The person in charge should walk round the laboratory once every morning and evening, and collect all such fat, heavy, opaque-looking creatures, and put them into a basin of half vinegar, half water; here they should be left 12 hours, and treated thus:— A board should be prepared, 30 in. by 6, with a row of pegs at each end, and notches all round the edges. Two intestinal canals run through the length of the silkworm; these should be separated from the head of the insect while in the vinegar and water, and the threads, one by one, drawn out rapidly to their full extent, and fixed at full stretch on the board, by means of the pegs and notches. Expedition is to be observed, as the air soon hardens the strings; they must on no account be passed through the finger and thumb, as they are of no value if flat. The yellow mucilage which clings to the strings is removed afterwards by being boiled in soap and water. When the Florence (for the time being) is drawn out, the board should be placed in the sun to dry. To clean the gut, take a bit of soap the size of a nutmeg, and boil it in a gallon of water. When the soap is dissolved, put the Florence into it, and boil for 10 minutes; take it out, and pass it through cotton, to remove what may remain of the yellow matter, but pass it so lightly that the gut, which becomes soft by boiling, may not be flattened. When again stretched and dried on the board, it becomes clear and strong. Experience alone can bring this to perfection, but it is worth the trial with silkworms which will not spin, and which would therefore be lost; and, if well made, Florence should sell for ½*d.* or 1*d.* the string, according to its length, strength, roundness, and clearness." There is room for experiment on other plant-eating caterpillars with a view to utilising them in this way.

HYDROGEN PEROXIDE.—Schönbein showed that the active principle of grass bleaching is ozonised oxygen, but the investigations of Schöne, Houzeau, and Goppelsröder prove that ozone is not formed in the air during the bleaching process; moreover, all reactions hitherto attributed to ozone are due to hydrogen peroxide. Although grass bleaching is effective, it is very slow, involving much time and expense. It is therefore of great importance to use a more economical process. All chemical substances hitherto used as substitutes for atmospheric oxygen injure the vegetable tissue to be bleached, some more than others. Hydrogen peroxide, however, is perfectly inactive in this respect. It has found many applications in the arts. In 1870 it was brought into commerce as a bleach for hair, under the name of "golden hair water," and simultaneously attention was drawn to its medicinal properties. The difficulty of preparing it on a large scale has hindered its general utility. Gradually, however, this has been overcome, and hydrogen peroxide is at the present time a commercial product easily obtainable and at reasonable prices. It is used on a large scale for bleaching substances of animal origin. To effect this, all fat and adhering impurities must be removed. The bleaching liquid is neutralised with ammonia, and during the operation all light should be excluded, and the temperature not raised above 77° F. (25° C.). The bleaching of hair is effected by digesting in ammonium carbonate, washing, soaping, and again immersing in solution of ammonium carbonate to remove all fat. The hair is steeped in a bath of hydrogen peroxide neutralised with ammonia. As a bleach for feathers, hydrogen peroxide is said to supersede all other substances. This applies also to the bleaching of silk. It has further been used with great advantage for bleaching ivory and bone. All fatty substances must first be removed. As to the application of hydrogen peroxide in medicine, it is maintained that all fermentation due to an organised ferment is immediately and definitely arrested by hydrogen peroxide, the ferment is killed, and even after the removal of the hydrogen peroxide by one of the substances which destroy it most rapidly, the fermentation does not recommence. Brewers' yeast is in this manner killed instantly, although it possesses itself the property of decomposing hydrogen peroxide. Specimens of wine, urine, and milk, each containing a few drops of hydrogen peroxide, have been exposed for several months in open vessels without exhibiting the least sign of alteration, while other specimens of the same identical liquid, without the addition of hydrogen peroxide, placed beside them, were in a state of complete decomposition. Soluble ferments do not seem to be affected by hydrogen peroxide, as saliva, diastase, the gastric and pancreatic fluids continue to act in solutions containing it. For surgical application as an antiseptic dressing, in injections, vaporizations, and internally, it may well replace carbolic acid preparations; but for such purposes it must be entirely neutral, whereas that ordinarily in commerce frequently contains a notable quantity of sulphuric acid. As a disinfectant, hydrogen peroxide has the advantage of being free from odour, giving up oxygen, leaving pure water as a residue, and having no injurious action on the organism. Sauer has used it in dentistry for bleaching discoloured and carious teeth.

Hydrogen peroxide may be prepared (1) by the action of dilute hydrochloric acid on barium dioxide, thus—

$$BaO_2+2\ HCl=H_2O_2+BaCl_2;$$

or (2) by passing a current of carbonic acid through water, and gradually adding barium dioxide in very small quantities, thus—

$$BaO_2+CO_2+H_2O=H_2O_2+BaCO_3;$$

or (3), which is the most generally adopted, by decomposing pure barium dioxide with dilute sulphuric acid, thus:—

$$BaO_2+H_2SO_4=H_2O_2+BaSO_4.$$

Watts gives the following account of this manufacture, taken from Thénard: "Pure baryta is prepared by igniting, in a porcelain retort, nitrate of barium free from iron and manganese. The baryta, broken into pieces about the size of a nut, is then put into a coated glass tube and heated to low redness, while a current of oxygen gas, free from carbonic acid and dried by means of quicklime, is passed over it. For the first 8 minutes the gas is eagerly absorbed by the baryta. After it has begun to escape from the farther end of the tube (to which a gas delivery-tube passing under water is fitted), the stream is still kept up for the space of 10 or 15 minutes. The peroxide of barium obtained by this process is, after cooling, preserved in a bottle. In the next place 200 grm. of water are mixed with as much hydrochloric acid as will neutralize 15 grm. baryta. Into this liquid, contained in a cylinder, or, better, in a dish of silver or platinum kept cool by surrounding it with ice, 12 grm. peroxide of barium, slightly moistened and rubbed up in an agate mortar, are introduced by means of a wooden spatula: on agitating or stirring the liquid with the pestle, the whole dissolves completely and without effervescence. The baryta is next precipitated by sulphuric acid, added drop by drop till slightly in excess: the presence of an excess of the acid may be known by the sulphate of barium falling down more quickly than before. 12 grm. more of the peroxide are then dissolved in the same liquid, and likewise precipitated by sulphuric acid. The liquid, which now contains hydrochloric acid, sulphuric acid, a large quantity of water, and a small quantity of peroxide of hydrogen, is next separated from the sulphate of barium by filtration, the precipitate washed with a little water, and the last wash-water retained for future washings. The filtrate is again mixed as above, twice with peroxide of barium, and twice with sulphuric acid. The filtration is then repeated, and the process continued in the same way, till 90 or 100 grm. of the peroxide are consumed. The liquid thus obtained would, on decomposition, yield 25 to 30 measures of oxygen gas. To separate silica, alumina, sesquioxide of iron, sesquioxide of manganese, &c., which proceed from the porcelain retort in which the nitrate of baryta was ignited, the liquid is mixed with concentrated solution of phosphoric acid (2 or 3 parts of phosphoric acid to 100 parts peroxide of barium), then surrounded with ice, and supersaturated with pounded peroxide of barium: silica, and the phosphates of iron, manganese, and aluminium, then separate rapidly in flakes, and must be removed from the liquid by filtration through linen, and if necessary through paper. The presence of a large quantity of sulphate of barium renders the filtration difficult (if no phosphoric acid were present, the sesquioxides of iron and manganese would fall down by themselves, and give rise to a rapid evolution of oxygen gas; but when they are mixed with phosphoric acid, they do not produce this effect). Should the liquid contain portions of these oxides, they must be separated by the addition of a slight excess of baryta water; whereupon the liquid must be immediately and rapidly filtered through several filters at once, and the filters squeezed between linen to get all out. The whole of the baryta must then be separated by carefully adding sulphuric acid in very slight excess, and filtering. The filtrate now contains nothing but water, peroxide of hydrogen, hydrochloric acid, and a very little sulphuric acid. To separate the hydrochloric acid, the liquid is surrounded with ice, and mixed with sulphate of silver. In the first place, sulphate of silver, obtained by heating nitrate of silver in contact with oil of vitriol in a platinum crucible, is introduced in the form of powder into the liquid—the whole being constantly stirred till the liquid becomes clear, a sign that the hydrochloric acid is wholly or nearly precipitated. Any hydrochloric acid that may still remain must be separated by cautiously adding more sulphate of silver. If the latter has been added in excess, it must be precipitated by carefully dropping in a dilute solution of chloride of barium. The liquid should contain neither hydrochloric acid nor silver, and should therefore give no precipitate, either with solution of silver or with hydrochloric acid. The chloride of silver is separated by filtration and pressure, any portion of liquid which comes through turbid being filtered over again. To remove the sulphuric acid also, and obtain a pure mixture of water and peroxide of hydrogen, the liquid is placed in a glass mortar surrounded with ice, and rubbed up with slaked baryta previously pounded and diffused through water: the baryta is added till the sulphuric acid is very nearly saturated. The liquid is then filtered, the filter pressed between linen, and baryta water added in slight excess.

This often occasions the precipitation of oxide of iron and oxide of manganese, as well as sulphate of barium; hence the filtration must be rapidly performed. The excess of baryta is removed by cautiously adding dilute sulphuric acid, so that there may be rather a very slight excess of the acid than of the baryta. The whole of the sulphuric acid may likewise be removed by means of carbonate of barium obtained in a finely-divided state by precipitation, instead of by slaked baryta and baryta water. Finally, to separate the whole of the water, the vessel containing the liquid is placed in a dish containing oil of vitriol, and the whole is put under the receiver of an air-pump; the water then evaporates before the peroxide of hydrogen. The fluid is agitated from time to time. If it should deposit flakes of silica, which give rise to the escape of oxygen gas, it must be decanted off from them by means of a siphon; if it should evolve oxygen—which it will do as soon as it is so far concentrated as to contain about 250 times its volume of oxygen—2 or 3 drops of sulphuric acid must be added to it. The concentration must be stopped after a few days, when the liquid is brought to such a state that when decomposed it would evolve 475 volumes of oxygen gas; for this residue, if left longer *in vacuo*, would evaporate as a whole. The peroxide of hydrogen must be kept in long glass tubes closed with stoppers and surrounded with ice; but even under these circumstances it decomposes slowly and evolves oxygen gas."

INK.—The term "ink" is used to denominate a great variety of fluid or semi-fluid compounds employed in the permanent delineation of objects upon paper, stone, glass, metals, leather, textiles, and other grounds. The chief desiderata in most inks are a capacity of flowing readily from the writing instrument, while possessing sufficient body to prevent spreading and blotching, combined with depth and permanency of colour. The latter naturally depends in a great measure upon the physical and chemical characters of the article written upon, and especially upon the presence or absence of bleaching agents. The composition of inks varies as widely as do the purposes to which they are applied; hence they may be classified as follows:—Black writing-ink, coloured writing-ink, copying-ink, engraving-ink, indelible inks, Indian ink, invisible ink, marking-ink, miscellaneous inks, printing-ink, stamping-inks.

Black Writing-ink.—The following are among the most approved recipes:—

A. WITH GALLS AND SULPHATE OF IRON.—(*a*) 1 lb. bruised galls, 1 gal. boiling water, 5⅓ oz. sulphate of iron (copperas) in solution, 3 oz. gum-arabic previously dissolved, and a few drops of an antiseptic, such as carbolic acid. Macerate the galls for 24 hours, strain the infusion, and add the other ingredients. (*b*) 12 oz. bruised galls macerated for a week in 1 gal. cold water, 6 oz. sulphate of iron in solution, 6 oz. mucilage of gum-arabic, and a few drops of antiseptic. (*c*) 12 lb. bruised galls, boiled for an hour in 6 gal. soft water, adding water to replace that evaporated; strain, and reboil the galls in 4 gal. more water for ½ hour; strain, and boil with 2½ gal. more water; strain, and mix the liquors. Add 4½ lb. coarsely powdered sulphate of iron, and 4 lb. gum-arabic in small pieces; agitate till the ingredients are dissolved, and filter through a hair sieve. This will make about 12 gal. of good ink. (*d*) 2 lb. bruised galls, digested in 2 qt. alcohol at a temperature of 104° to 140° F. (40° to 60° C.); when about half the alcohol has evaporated, add 3 qt. water; stir well, and strain through a linen cloth. To clarify the solution, add 8 oz. glycerine, 8 oz. gum-arabic, and 1 lb. sulphate of iron dissolved in water. Stir thoroughly from time to time for a few days, allow to settle, and put up in well-stoppered bottles for preservation. The addition of too much sulphate of iron is to be avoided, as causing the ink soon to turn yellow. Ink thus prepared is said to resist the action of light and air for at least 12 months, without suffering any change of colour. (*e*) Digest in an open vessel 42 oz. coarsely-powdered galls, 15 oz. gum-senegal, 18 oz. sulphate of iron, 3 dr. aqua ammoniæ, 24 oz. alcohol, and 18 qt. distilled or rain water. Continue the digestion till the fluid has assumed a deep black colour. (*f*) To good gall-ink add a strong solution of fine Prussian blue in distilled water; the ink writes greenish blue, but afterwards turns black; it is said that it cannot be erased either by acids or alkalies without the destruction of the paper. (*g*) Take blue Aleppo galls free from insect perforations, 5½ oz.; bruised cloves, 1 dr.; cold soft water, 3½ pints; purified sulphate of iron, 1½ oz.; sulphuric acid by measure, 35 minims; sulphate of indigo, in the form of a thin paste, and which should be neutral or nearly so, ½ oz. Digest together in a closed vessel, with occasional agitation, for two weeks, the galls, cloves, and water. Then filter through a piece of cotton cloth, and press out as much of the liquid as possible from the sediment. Dissolve in this completely the powdered sulphate of iron, stir in briskly the acid, then the indigo, and filter the liquid through the paper (filter-paper). In all the inks described in this section, nut-galls are introduced for the sake of their tannic acid. For this purpose they are not equalled by any other tannin-yielding substance; and a Commission lately appointed by the Prussian Government to decide what was the best ink to be employed for official purposes, selected that made from galls as being the foremost of all for durability. For cheaper inks the galls may be replaced by catechu, sumach, and a host of other astringent substances. The antiseptic (carbolic acid, &c.) is added to prevent the formation of mould.

B. WITH LOGWOOD.—(*a*) A decoction of logwood is first made by boiling 10 lb. logwood in enough water to produce 80 lb. of the decoction. To 1000 parts of this logwood extract, when cold, is added 1 part of yellow (neutral) chromate of potash (K_2CrO_4), stirring rapidly. It is ready for use at once, without any addition; but it possesses the great fault of soon becoming thick. This may be corrected by (*b*) adding corrosive sublimate or any other antiseptic. (*c*) Boil 10 oz. logwood in 20 oz. water; then boil again in 20 oz. more water, and mix the two decoctions; add 2 oz. chrome alum, and boil again for ½ hour; and 1 oz. gum-arabic. The product is 25 oz. deep black ink. (*d*) Runge, in 1848, discovered that a dilute solution of the colouring matter of logwood, to which had been added a small quantity of neutral chromate of potassium, produces a deep black liquid, which remains clear, does not deposit, and may be employed as an ink. Perfectly neutral litmus paper is not affected by it, it does not attack pens, it is very cheap, and so easily penetrates writing-paper that it cannot be removed by washing even with a sponge—in a word, it has all the properties of an excellent ink. On exposure to the air in an inkstand, it sometimes decomposes very rapidly, its colouring matter being deposited in the form of large black flakes, which leave a colourless liquid above them. This gelatinisation is a great defect in this ink, particularly as one does not know the precise conditions that determine it. Different means have been proposed to prevent this action; the best seems to be that of the addition of carbonate of sodium, recommended by Böttger. To prepare this ink, take extract of logwood, 15 parts; water, 1000 parts; crystallised carbonate of sodium, 4 parts; neutral chromate of potassium, 1 part. Dissolve the extract of logwood in 900 parts of water, allow it to deposit, decant, heat to ebullition, and add the carbonate of soda; lastly, add drop by drop, with constant stirring, a solution of the neutral chromate in 100 parts of water. The ink thus obtained has a fine bluish-black colour; it flows well from the pen, and dries readily. The chrome ink powder of Platzer and the acid ink of Poncelot are imitations of the original ink of Runge. (*e*) 10 lb. best logwood is repeatedly boiled in 10 gal. water, straining each time. The liquid is evaporated down till it weighs 100 lb., and is then allowed to boil in a pan of stoneware or enamel. To the boiling liquid, nitrate of oxide of chrome is added in small quantities until the bronze-coloured precipitate formed at first is redissolved with a deep blue coloration. This solution is then evaporated in a water bath down to a syrup, with which is mixed well-kneaded clay in the proportion of 1 part of clay to 3½ of extract. A little gum-tragacanth is also added to obtain a proper consistence. It is absolutely necessary to use the chrome salt in the right proportion. An excess gives a disagreeable appearance to the writing; while, if too little is used, the black matter is not sufficiently soluble. The other chrome salts cannot be used in this preparation, as they would crystallise, and the writing would scale off as it dried. The nitrate of oxide of chrome is prepared by precipitating a hot solution of chrome alum with carbonate of soda. The precipitate is washed till the filtrate is free from sulphuric acid. The precipitate thus obtained is dissolved in pure nitric acid, so as to leave a little still undissolved. Hence the solution contains no free acid, which would give the ink a dirty-red colour. Oxalic acid and caustic alkalies do not attack the writing. Dilute nitric acid reddens, but does not obliterate the characters. This ink is manufactured into ink-pencils, which give a very black writing, capable of reproduction in the copying-press, and not fading on exposure to light. (*f*) 20 parts by weight extract of logwood are dissolved in 200 parts water, and the solution is clarified by subsidence and decantation. A yellowish-brown liquid is thus obtained. In another vessel, 10 parts ammonia alum are dissolved in 20 parts boiling water; the two solutions are mixed, there being also added ⅕ part sulphuric acid, and finally 1½ part sulphate of copper. The ink should be exposed to the air for a few days to give it a good colour, after which it should be stored in well-corked bottles. (*g*) 30 parts extract of logwood are dissolved in 250 parts of water; 8 parts crystallised carbonate of soda, and 30 parts glycerine (sp. gr. 1·25), are added; lastly, 1 part neutral chromate of potash and 8 parts gum-arabic, reduced to a powder and dissolved in water. This ink does not attack pens, does not turn mouldy, and is very black. (*h*) That which is called in trade "alizarine ink" has nothing in common with alizarine, either natural or artificial. The name was applied to an improved kind of ink over 30 years ago. It is a writing fluid in which the iron is maintained in a *ferrous* (protoxide) condition, and in perfect solution, which is accomplished by slightly acidulating the liquid with acetic or sometimes with sulphuric acid. The liquid has usually a rather pale greenish or bluish colour, and the writing is at first green, not black. Not long afterwards, however, the acid menstruum evaporates, leaving a very thin layer of the ferrous tannate, which gradually oxidises in the air, and turns to black ferric tannate. Contrary to what might be expected, steel pens are not usually much corroded by properly prepared alizarine inks; the first coating of oxide which is produced upon the pen generally adheres so firmly that further action is very much retarded. The very pale tint of such a writing-fluid is frequently heightened by the addition of some indigo-solution, best in form of indigo-carmine. A good formula for making so-called alizarine ink is the following:—Powdered nutgalls, 40 parts; solution of acetate of iron, 15; gum-arabic, 10; wood-vinegar, 10; indigo-carmine, 5; and water, 100 parts. Prepare the solution of acetate of iron by pouring a sufficient quantity of wood-vinegar upon scrap-iron contained in a cask, and allow it to act upon the iron for at least 8 days. Macerate the powdered nutgalls for 8 days with the 100 parts of water mixed with the 10 parts of wood-vinegar. Before mixing the strained liquid obtained from the nutgalls with the iron solution, it is necessary to ascertain whether the quantity of acetic acid present is sufficient to keep the ferrous acetate in solution. For this purpose 10 volumes of the liquid nutgall extract are mixed with one volume of the iron solution. If a clear mixture results, and of a dark-green colour in thin layers, the liquid contains enough acid; but if a black opaque liquid results, the acid is deficient. In the latter case more wood-vinegar must be very gradually and cautiously added from a measured volume, until the liquid is clear and dark green, and the requisite amount of acid, determined by this experiment, must be added to the extract of nut-galls. The gum-arabic is next dissolved in the latter, the iron solution then added, and finally the indigo-carmine, or as much thereof as may be required to produce the desired tint. (*New Remedies.*) (*i*) Decoctions of logwood to which alum has been added give a reddish or violet colour, which darkens slowly, particularly with ink prepared from the wood and not the extract. Such inks prepared with alum alone are costly, because to obtain a sufficiently deep tint one is obliged to employ decoctions or solutions of the extract in a very concentrated condition. It is otherwise when a metallic salt is added along with the alum. Alum produces a reddish purple colour in decoctions of logwood, while metallic salts produce in the oxidised solution of the colouring matter a precipitate of a black or bluish-black colour. These inks are analogous to the so-called alizarine inks; the ink is coloured by the tint produced by the alum. Under the influence of air there is produced between the metallic salts and the colouring matter a reaction which determines the formation of a bluish-black precipitate. To prevent as much as possible this action of the air upon the ink before it is applied to the paper, there is added, as in the case of alizarine inks, a trace of sulphuric acid, designed to dissolve the precipitate which may be produced. This acidity of the ink has several disadvantages; it attacks the pens used for writing with it unless they are either of gold, platinum, or gutta-percha. Sulphate of copper or sulphate of iron may be the metallic salts used in such inks; the former is preferable.

C. Miscellaneous.—(*a*) The juice or sap of the ink-plant (*Coriaria thymifolia*) of New Granada, to which is given the name of *chanchi*, is at first of a reddish tint, but in a few hours becomes intensely black. It may be used without any preparation. The *chanchi* corrodes steel pens less than ordinary ink, and better resists the action of time and chemical agents. It is said that during the Spanish rule all public documents were required to be written with this ink; written otherwise, they were liable to damage by sea-water. (*b*) 20 gr. sugar is dissolved in 30 gr. water, and a few drops concentrated sulphuric acid are added; the mixture is heated, when the sugar is carbonised by the acid. (*c*) It is well known that aniline black, properly so called, is nearly insoluble in most chemical re-agents. It is applied to textile fabrics in a pounded state, or developed on the texture or paper by the reaction of a salt of copper on hydrochlorate of aniline. It thus furnishes an intense and indelible black. But a mixture of salt of copper and hydrochlorate of aniline is not long in the air without undergoing great changes. It soon turns to green and deposits insoluble aniline black. This prevents the use of this black for flowing ink. Latterly, however, it has been found possible to prepare, with aniline and methyl, colouring substances of a bluish-black shade, so intense and soluble in water that they can be used in the preparation of beautiful black writing-ink. One of these substances is an article of commerce under the name of soluble nigrosine. It dissolves in water with a slight residue, and, without thickening, furnishes a beautiful blue-black, which is purple in reflected light, and immediately becomes intense black on paper. It is, consequently, an ink that does not change, flows easily from the pen, does not turn brown, and when dry can be again rendered fluid with a little water. It does not possess the intensity of the black from gallnut, but a softer and more velvety tone. Although prepared with a soluble salt, it is not obliterated when dry, and not easily when moistened, unless it is too thick. On the other hand, the fibre of the paper does not completely absorb this colouring substance; the residue continues as a deposit on the surface, and can be removed. This imperfection may be remedied by diluting the black with water. Acids change the characteristics into blue without destroying them, and, on account of the perfectly neutral reaction of nigrosine, this ink does not at all attack steel pens and render them unfit for use. (*Technologiste.*) (*d*) Berzelius found that by treating an infusion of galls by a solution of vanadate of ammonia, in place of sulphate of iron, he could produce an ink of remarkably good quality. At the time of his discovery, in 1831, it was of no practical interest, because the vanadates were very costly. At the present time their cost has been so much reduced that his recipe can be employed for ordinary inks, which have the additional advantage of presenting great resistance to most reagents and destructive materials. Gum-arabic can be dispensed with, and the chance of moulding or alteration thus reduced. (*Chron. Industr.*) (*e*) Peltz, in the 'Pharm. Zeitschr. für Russland,' recommends:—

	Parts
Extr. logwood	100
Lime-water	800
Carbolic acid	3
Crude hydrochloric acid ..	25
Distilled water	600
Gum-arabic	30
Bichromate of potash	3
Distilled water to make up the weight to	1800

The ink should be made in a porcelain or enamelled iron vessel. The extract is first dissolved in the lime-water over a steam-bath with frequent stirring. To these are added the carbolic and hydrochloric acids, which change the solution from a red to a brownish-yellow colour. After half-an-hour's heating over the steam-bath, the mixture is set aside till cold, when it is strained or filtered. Lastly, the gum and the bichromate, each separately dissolved in a considerable quantity of distilled water, are added, and the remainder of the water to make up the necessary weight. This ink is of a fine red colour, which quickly turns black; it does not corrode steel pens; and if it dries, needs only the addition of water. (*f*) Joseph Ellis, of Brighton, stated to the Society of Arts that, by making a solution of shellac with borax in water and pure lamp-black, an ink is producible which is indestructible by time or by chemical agents, and which, on drying, will present a polished surface, as with the ink found on the Egyptian papyri. He made such an ink, and proved, if not its identity with that of ancient Egypt, yet the correctness of the formula.

Coloured Writing-ink. — Coloured inks may be divided into two classes, those in which the colouring matter is derived from coal-tar, and those in which it is not.

A. WITHOUT COAL-TAR COLOURS.—*Blue.*—(*a*) Dissolve 2 to 3 oz. sulphate of indigo in 1 gal. water. (*b*) Rub together 1 oz. oxalic acid and 2 oz. fine Prussian blue, and add 1 qt. boiling water; the excess of iron in the Prussian blue must first be removed by a strong mineral acid; then wash in rain-water. (*c*) 2 oz. Chinese blue, 1 qt. boiling water, 1 oz. oxalic acid; dissolve the blue in the water, and add the acid; it is ready for use at once.

Green.—(*a*) Calcine acetonitrate of chrome; dissolve the green powder in sufficient water. (*b*) Dissolve sap green in very weak alum water. (*c*) 2 oz. verdigris, 1 oz. cream of tartar, ½ pint water; boil till reduced to one-half, and filter.

Green-black.—Boil 15 parts bruised galls in 200 parts water for about 1 hour; strain; to the liquor add 5 parts sulphate of iron, 4 fine iron shavings, and a solution of ½ pint powdered indigo in 3 pints sulphuric acid. This ink flows readily; it writes green, but turns black after a few days.

Purple: (*a*) To a decoction of 12 parts Campeachy wood in 120 parts water, add 1 part subacetate of copper, 14 parts alum, and 4 parts gum-arabic; let stand for 4 to 5 days. (*b*) To a strong decoction of logwood add a little alum or chloride of tin.

Red.—(*a*) 4 oz. ground Brazil-wood and 3 pints vinegar, boiled till reduced to 1½ pint, and 3 oz. powdered rock-alum added. (*b*) ¼ lb. raspings of Brazil-wood, infused in vinegar for 2 to 3 days; boil the infusion for 1 hour over a gentle fire, and filter while hot; put it again on the fire, and dissolve in it, first, ½ oz. gum-arabic, then ½ oz. alum and white sugar. (*c*) Boil 2 oz. Brazil wood in 32 oz. water; strain the decoction; add ½ oz. chloride of tin and 1 dr. powdered gum-arabic; then evaporate to 16 fl. oz. (*d*) Dissolve 1 dr. carmine in ½ dr. liquid ammonia, sp. gr. 0·880; dissolve 20 gr. powdered gum-arabic in 3 oz. water; mix the two solutions. (*e*) Mix 2000 parts Brazil-wood, 3 salt of tin, 6 gum, and 3200 water; boil till reduced to one-half, and filter. (*f*) 2 parts Brazil-wood, ½ alum, ½ cream of tartar, 16 water; boil down to ½, and filter; add ½ part gum. (*g*) To an ammoniacal solution of cochineal add a mixture of alum and cream of tartar, till the required tint is obtained. (*h*) Digest 1 oz. powdered cochineal in ½ pint hot water; when quite cold, add ½ pint spirit of hartshorn; macerate for a few days, then decant the clear portion. (*i*) Dissolve 20 gr. pure carmine in 3 fl. oz. liquid ammonia; add 18 gr. powdered gum. (*j*) Best ground Brazil-wood, 2 oz.; diluted acetic acid, ½ pint; alum, ¼ oz. Boil them slowly in an enamelled vessel for half an hour, strain, and add ½ oz. of gum. (*k*) 1 qt. of white wine vinegar, 2 oz. of Brazil-wood, and ½ oz. of alum, bottled and well shaken for a fortnight; then let simmer in a saucepan, and add ¾ oz. of gum-arabic. Let the whole stand for a few days, filter, and it will be ready for use. (*l*) Boil 4 oz. of Pernambuco-wood with 16 oz. of dilute acetic acid, and an equal quantity of water, until 24 oz. remain. Add an ounce of alum, and evaporate again to 16 oz.; add gum-arabic 1 oz. and strain; and lastly, add to the cold liquid 1 dr. protochloride of tin. (*m*) The solubility of carmine lake in caustic aqua ammoniæ is attended with this disadvantage: that in consequence of the alkaline properties of ammonia, the cochineal pigment will in time form a basic compound which, in contact with a steel pen, no longer produces the intense red, but rather a blackish colour. To avoid this evil, prepare the ink as follows:—Triturate 1 oz. of pure carmine with 15 oz. of acetate of ammonia solution, and an equal quantity of distilled water, in a porcelain mortar, and allow the whole to stand for some time. In this way a portion of the alumina which is combined with the carmine dye is taken up by the acetic acid of the ammonia salt, and separates as precipitate, while the pure pigment of the cochineal remains dissolved in the half-saturated ammonia. It is now filtered, and a few drops of pure white syrup added to thicken it. In this way an excellent red drawing-ink is obtained, which holds its colour a long time. A solution of gum-arabic cannot be employed to thicken this ink, as it still contains some acetic acid, which would coagulate the bassorine, which is one of the natural constituents of gum-arabic. (*n*) Böttger rubs up carmine and silicate of soda, and then adds to this mixture a concentrated silicate solution till the whole is of sufficient consistency to write well. The product gives a very brilliant ink when dry, and dries quickly. It must be kept out of contact of air in a well-closed vessel.

Violet.—(*a*) Boil 8 oz. logwood in 3 pints water, till reduced to 1½ pint; strain, and add 1½ oz. gum and 2½ oz. alum. (*b*) Mix 1 oz. cudbear, 1½ oz. pearlash, and 1 pint hot water; allow to stand for 12 hours; strain, and add about 2 oz. gum. If required to keep, add 1 oz. spirit of wine.

B. WITH COAL-TAR COLOURS.—The colouring matters derived from coal-tar may all be employed for writing purposes. These inks possess bright colours, do not precipitate their colour, and dry quickly. When dried up or thickened, they can be put right by simple dilution with water. On the other hand, they are readily destroyed by chemical reagents. They must not be used with pens which have been employed in writing with other inks. They do not require any addition of gum; but if desired, 1 part dextrine may be added to every 100 parts ink. Almost all tints may be produced by mixtures, in varying proportions, of the following principal colours:—

Blue.—1 part soluble blue (night blue) in 200 to 250 parts hot water; if the ink dries with a coppery hue, more water must be added.

Green.—1 part iodine-green in 100 to 110 parts hot water. Gives a bluish-green writing; for a lighter tint, add a little picric acid.

Red.—(*a*) 1 part magenta in 150 to 200 parts hot water. (*b*) Dissolve 25 parts (by weight) safranine in 500 parts warm glycerine; then stir in carefully 500 parts alcohol, and 500 parts acetic acid; dilute in 9000 parts water, containing a little gum-arabic in solution. (*c*) Get a small quantity of magenta crystals—as many, for instance, as will lie on a sixpence, or at most on a shilling—place them in an egg-cup, and cover them with water. In a short time you will have a solution of a fine magenta colour. A little Indian ink well rubbed up, with a few drops of Judson's dye (Oxford blue) added, will intensify the colour.

Violet.—1 part violet-blue in 200 parts hot water.

Yellow.—1 part picric acid in 120 to 140 parts water. This is not very successful.

Copying-ink.—The quality required of a copying-ink is that it shall afford one or more copies of the written matter by applying dry or damped paper to its surface, and subjecting it to more or less pressure. The best kinds of copying-ink are usually prepared by adding a little alum to an extract of logwood of 10° B. (1·075 sp. gr.), or to a decoction of the same, and then, to improve its copying power, some sugar and glycerine or table-salt is added. Such inks have a violet tint, are purple when first written, and gradually darken on the paper. The copies taken from them are at first very pale, and only slowly darken. The chief recipes for copying-inks are the following:—(*a*) Mix about 3 pints of jet-black writing-ink and 1 pint glycerine. This, if used on glazed paper, will not dry for hours, and will yield one or two fair, neat, dry copies, by simple pressure of the hand in any good letter copy-book. The writing should not be excessively fine, nor the strokes uneven or heavy. To prevent "setting-off," the leaves after copying should be removed by blotting-paper. The copies and the originals are neater than when water is used. (*b*) A good copying-ink may be made from common violet writing-ink by the addition of 6 parts glycerine to 8 parts of the ink. Using only 5 parts of glycerine to 8 of the ink, the ink will copy well 15 minutes after it has been used. With fine white copying-paper, it will copy well without the use of a press. (*c*) ½ lb. extract of logwood, 2 oz. alum, 4 dr. blue vitriol (sulphate of copper), 4 dr. green vitriol (sulphate of iron), 1 oz. sugar; boil these ingredients with 4 parts water, filter the decoction through flannel; add a solution of 4 dr. neutral chromate of potash in 4 oz. water, and a solution of 2 oz. "chemick blue" in 2 oz. glycerine. The "chemick blue" is the solution of indigo in sulphuric acid, or sulphindigotic acid. (*d*) A black copying-ink, which flows easily from the pen, and will give very sharp copies without the aid of a press, can be prepared thus:—1 oz. coarsely-broken extract of logwood and 2 dr. crystallised carbonate of soda are placed in a porcelain capsule with 8 oz. distilled water, and heated until the solution is of a deep red colour, and all the extract is dissolved. The capsule is then taken from the fire. Stir well into the mixture 1 oz. glycerine (sp. gr. 1·25), 15 gr. neutral chromate of potash, dissolved in a little water, and 2 dr. finely-pulverised gum-arabic, which may be previously dissolved in a little hot water so as to produce a mucilaginous solution. The ink is now complete and ready for use. In well-closed bottles it may be kept for a long time without getting mouldy, and, however old it may be, it will allow copies of writing to be taken without the aid of a press. It does not attack steel pens. This ink cannot be used with a copying-press. Its impression is taken on thin moistened copying-paper, at the back of which is placed a sheet of writing-paper. (*e*) A new kind of Parisian copying-ink has been recently introduced into Germany, which differs from those previously in use in having, while liquid, a more or less yellowish-red colour; but on paper it rapidly turns blue, and immediately produces a distinct blue-black copying-ink; moreover, it remains liquid a long time, while ordinary violet copying-ink soon gets thick. This kind copies easily and perfectly. The following is the method of its manufacture:—A logwood extract of 10° B. (sp. gr. 1·075) has added to it 1 per cent. of alum, and then enough lime-water to form a permanent precipitate. This mass is then treated with a few drops of a dilute solution of chloride of lime (bleaching-powder), just enough being added to impart to it a distinct blue-black colour, after which dilute hydrochloric acid is added drop by drop until a distinctly red-coloured solution is produced. To this solution is added a little gum, and 1 to 1½ per cent. of glycerine. It is evident that the small quantity of chloride of calcium formed by this process greatly increases the copying power of the ink; while the exceedingly slight excess of free hydrochloric acid causes the ink to remain liquid, by holding in solution the lime and alumina lakes of logwood. When the writing dries, the acid gradually escapes, or is neutralised by the trace of alkali in the paper, so that the blue-black lake is left. It is evident that any considerable excess of hydrochloric acid must be avoided, as also the use of too much chloride of lime solution. (*f*) Add 1 oz. lump-sugar or sugar-candy to 1½ pint good black ink; dissolve. (*g*) A decoction of Brazil-wood and glycerine used as an ink requires neither press nor copying-paper for multiplying the impressions; it is only necessary to lay tissue-paper upon the writing and to rub with the finger. (*h*) 5½ oz. best galls, 1 dr. bruised cloves, 40 oz. cold water, 1½ oz. pure sulphate of iron, 35 minims pure sulphuric acid, ¼ oz. sulphate of indigo in thin paste, and neutral or nearly so. Place the galls, when bruised, with the cloves in a 50-oz. bottle, pour in the water, and digest, shaking daily, for a fortnight. Filter through paper into another 50-oz. bottle. From the refuse of the galls wring out the remaining liquor through a strong clean linen or cotton cloth into the filter to avoid waste. Put in the iron, dissolve completely, and filter through paper. Add the acid, and agitate briskly; add the indigo, and shake up thoroughly; pass the whole through filter-paper. Filter from one bottle to another till the operation is complete. The same ingredients may be used for common writing-ink, reducing the proportion of galls to 4½ oz. (*i*) 1 lb. Aleppo nut-galls, bruised; ½ lb. sulphate of iron (copperas), pounded; ¼ lb. gum-arabic, pounded; ½ lb. white sugar-candy, pounded; 1 gal. water. Put the above into an earthenware bottle, and keep about "new milk" warm for a week; a few cloves will prevent "moulding." Cost to make a gallon, about 2s. 8*d.* The bottle should have a good shaking three or four times a day. (*j*) Gum, ½ oz.; Spanish liquorice, 20 gr.; in 13 dr. of water, and add to it 1 dr. of lampblack, with a teaspoonful of sherry.

Engraving-inks.—Under the term "engraving-inks" will be included all inks employed for engravers, whether on stone, wood, or metal.

BLACK.—(*a*) Coal-tar, 100 parts; lampblack, 36; Prussian blue, 10; glycerine, 10. This ink may be used for lithography, chromo-lithography, autography, &c. (*b*) To the varnish obtained by boiling linseed-oil, as for printing-ink, is added as much best calcined Paris black as can be ground up with it. This is a litho-printing-ink. For copper-plate printing, the Paris black is replaced by lampblack.

(*c*) 8 oz. mastic in tears, 12 oz. shellac, 1 oz. Venice turpentine; melt together; add 1 lb. wax, 6 oz. tallow; when they are dissolved, add 6 oz. hard tallow soap-shavings, and mix; then add 4 oz. lampblack. Mix all well together, let cool slightly, pour into moulds, and cut into cakes of convenient size. This ink is suited for writing on stones. (*d*) To render (*c*) liquid, for writing and drawing on transfer-paper, it is warmed in a pot, and then rubbed down with soft water (rain or distilled water). The pen should be dipped into oil, and wiped, before use. (*e*) Pure white wax, 4 parts (best quality); white tallow, 2 parts; gum lac, 2 parts; lampblack, made from burnt rags, 1 part; oil copal varnish, 1 part. Melt the wax over a slow fire, then add gum lac crushed small, then mix in the soap in shavings, then the oil varnish for cakes. When wanted, thin with water from the cake, and for crayons cut from the paint, which must be brittle if it is good.

COLOURED.—Coloured inks are made by adding to the varnish already described certain pigments, of which the principal are as follows:—

Blue.—2 oz. celestial blue, 3 oz. marine blue.

Brown.—2 oz. burnt umber, 1 oz. rose-pink.

Green.—2 oz. mineral green, 3 oz. chrome-green.

Lilac.—1 oz. Prussian blue, 2 oz. Chinese red.

Orange.—2 oz. orange-red, 1 oz. flake-white, ground up with Canada balsam, and omitting the linseed-oil varnish.

Pink.—2 oz. mineral pink, 1 oz. satin-white.

Red.—5 oz. mineral orange-red, 2 oz. Chinese red.

Indelible Inks.—These are intended for use in cheques, vouchers, and other valuable documents, the object being to prevent tampering with the writing, and expose any such attempt if made. The following recipes have been published:—(1) An ink that cannot be erased, even with acids, is obtained by the following: To good gall ink, add a strong solution of fine soluble Prussian blue in distilled water. This addition makes the ink, which was previously proof against alkalies, equally proof against acids, and forms a writing fluid which cannot be erased without destruction of the paper. The ink writes greenish blue, but afterwards turns black. (*Pharmacist.*) (2) Mathieu Plessy, who has long manufactured a peculiar ink much used in France, has taken out a patent for the application of organic matter and a chemical substance which, when united in the ink, can be converted into carbon by the application of heat not sufficient to destroy the paper, parchment, or other substance on which it is used. The inventor claims to use any organic matter soluble in water or any other vehicle, such as cane sugar, caramel, glucose, or any of the vegetable substances which give glucose by reaction, such as sugar of milk. To accelerate the carbonisation, with heat, of the above substances, acid or neutral salts with alkaline earthy bases, or metallic oxides which do not affect the paper or parchment, or other similar substances, are employed. The heat of a hot-air stove at a temperature between 230° and 237° F. (110° to 114° C.), a plate of heated metal, or a hot iron, may be employed for the carbonisation, according to circumstances. (3) A very little quantity of aniline black triturated with a mixture of alcohol and hydrochloric acid, and the liquid obtained diluted with about twice its weight of water containing a trace of gum-arabic, gives an ink which proves indestructible alike with respect to strong mineral acids and towards concentrated lyes. (*Bayer. Ind.- und Gew. Blatt.*) (4) Dissolve 25 gr. of gum copal powder in 200 gr. of lavender oil by the aid of a gentle heat; then add 2½ gr. of lampblack and ½ gr. of powdered indigo. To be applied to paper with a quill pen. (5) Elsner prepares an ink which resists the action of bleaching agents, thus:—Take equal parts of copperas and vermilion, powder thoroughly, sift, and grind the finest portions with linseed-oil; finally squeeze through linen. A thick paste is thus obtained, which can be used either for writing or printing on calico or wool. (*Les Mondes.*) (6) Böttger prepares an ink that does not corrode steel-pens by triturating 3·65 gr. of aniline black with 22 gr. of alcohol, and 4 drops of hydrochloric acid; a porcelain mortar is employed, and the paste thus produced is mixed with 1·82 gr. of gum-arabic previously dissolved in 85 gr. of hot water. If this ink be added to an alcoholic solution of shellac (21 gr. of lac to 85 of alcohol), a black product results, suitable for colouring leather and wood. (*Dingler's Polytech. Jl.*) (7) If the ink is to be used for writing or drawing, and there is no danger of the letters, &c., being rubbed off mechanically, printing-ink or Indian ink may be used. (8) Printing-ink sinks into woven fabrics to a considerable depth, and will last a long time. It is probably one of the cheapest marking-inks to be used with stencils. (9) In many cases Indian ink answers as well, and in some cases, as for engrossing valuable documents, it is the only safe ink, since nothing but the destruction of the document itself will be able to obliterate it. It is made by triturating 100 gr. of best Indian ink (Chinese) with very dilute hydrochloric acid (about 22 parts of absolute hydrochloric acid in 1000 parts), or with a solution of acetate of manganese in diluted acetic acid. (10) Another fine indelible ink, which resists all ordinary reagents, is made by means of vanadium. Vanadium and its salts are rather expensive still, although their price has fallen during the last few years to about one-tenth of what it was formerly. (11) An indelible aniline ink may be made thus: 100 gr. of hydrochlorate of aniline and 60 gr. of chlorate of sodium are dissolved in 3½ oz. of water, and ½ gr. of vanadate of ammonium added to the liquid, when it will soon become dark-coloured, and deposit an abundant precipitate of aniline black. This may be dried, made into a paste with powdered acacia, water, and glycerine, and used with a stencil. (12) 1 part of pyrogallic acid is triturated with 3 parts of powdered acacia, 3 parts of vanadate of ammonium, and a sufficient quantity of cold distilled water, in a porcelain capsule, until a uniform mixture is made. This forms a fine ink, flowing black from the pen. This may also be made into a stencil ink by using less water and adding a little glycerine. (13) A composition prepared by mixing well triturated carbon with an alkaline silicate (potash or soda), the following proportions answering well:—lamp-black, 1 part; syrupy silicate solution, 12; ammonia liquor, 1; distilled water, 38. (14) (*a*) 1 lb. extract of logwood, 1 gal. water; (*b*) 4 oz. sulphate of protoxide of iron, 4 oz. water; (*c*) ¼ oz. potassium sulphide, 2 oz. water. After dissolving the logwood by boiling, add (*c*) to (*b*), until the iron assumes a black colour; then add this compound to (*a*), and boil a few minutes; add ½ oz. potassium cyanide, which fixes the colour; for ink, add gum and alcohol. (15) Take 1½ part by measure of a cold saturated aqueous solution of cupric chloride, saturated at 59° F. (15° C.); 20 parts by measure of a cold saturated aqueous solution of chloride of aniline; 20 parts by measure of water; 50 parts by measure of an aqueous solution of gum-arabic (1 part by weight of gum-arabic to 2 of water) at 59° F. (15° C.); 2 parts by measure of glycerine; and some finely-powdered potassium chlorate. In mixing the ingredients, it is preferable to add the solution of chloride of aniline to that of cupric chloride first, and the other ingredients in the order named; then, when the whole has been well shaken, to add powdered potassium chlorate in sufficient quantity to saturate, at 59° F. (15° C.), the compound solution so formed. After writing, the ink is at first slate-coloured, but on warming gently it becomes black. All the solutions are to be made at 59° F. (15° C.), that is, practically, the average temperature.

H. and W. S. Richmond, of New York, supply indelible cancelling inks, well adapted for marking postage and other stamps; they can, by suitable dilution, be used for legal, commercial, and other writings, in which permanency of the ink is of importance. The inks consist of the following ingredients, namely:—Eosine, aniline black, aniline blue, cupric chloride, sodium chlorate, ammonium chloride (sal-ammoniac), glycerine, lampblack, water, and oil. These substances are taken in the following proportions:—Eosine, 1 part; aniline black, 4; aniline blue, 2; cupric chloride, 1; ammonium chloride, 3; sodium chlorate, 2; and of the remaining ingredients a sufficient quantity to bring the ink to the proper consistency for the use for which it is intended. The ingredients are thoroughly incorporated by grinding or stirring, when the composition is ready for use. The ink described is absolutely indelible. Stamps cancelled therewith are effectually destroyed, and the fraudulent alteration of matter written therewith is impossible. The rationale of the operation of the ink is as follows:—Besides having as an ingredient aniline black, it embodies also the substances necessary to produce that colour—to wit, an aniline, an oxidizing agent, and a cupric salt. The reaction of these substances is, however, retarded by the oil, which also forms a part of the ink. As a consequence, the aniline black, which is a product of the reaction of the ingredients of the ink, is partly formed within the body of the stamp paper. In preparing the composition for ordinary *writing-ink*, the oil and lampblack are preferably omitted, a small portion of gum-arabic being added in their stead, the latter subserving the same end as the oil. To prevent moulding, a small proportion of some antiseptic agent, such as salicylic acid, may also be added. The novelty consists essentially in such a compound as contains the ingredients for forming aniline black, and for retarding the reaction sufficiently to defer its completion until after the ink shall have been applied to the paper or surface upon which it is to be used.

Indian Ink.—The peculiar ink employed by draughtsmen is termed "Indian," because the best qualities have always come to us from India and China. In the latter country the manufacture of drawing-inks is a large industry, and several factories are to be found in Shanghae and other parts of the empire.

A. The Chinese mode of manufacture is as follows:—In some parts of N. China, the lampblack, which forms the foundation of the ink, is prepared much in the same manner as in Europe. In other districts the following method prevails:—The furnaces are built upon the ground, with a length varying from 8 ft. to 40 ft., or even 50 ft., and with a mouth about 2 ft. in diameter. The material generally used is pine, or other resinous wood, or the resin itself, which is burned at the mouth of the furnace. Only the black deposited at the extreme end of the furnace is used for the finest ink, all the remainder being proportionately coarser. The fineness of the grain depends also upon the slowness of the combustion. The very finest black is said to be derived from pork-fat; the next from oils and other kinds of grease. The smoothness of the ink is likewise largely dependent upon the careful sifting of the black through silken bags or sieves. The first operation in compounding the ink is to soak a quantity of the excellent glue made from buffalo-hide; when thoroughly swollen, it is set aside, and will keep in this state for several days. For use, the glue is melted in an iron pot, and as much lampblack is added as will produce a soft paste. This paste is very carefully kneaded by hand. A small quantity of pea-oil is then added, and the whole is maintained at a temperature of 130° to 140° F. (54° to 60° C.), until the paste is found to be perfectly homogeneous. It is then poured out in the form of flat cakes, weighing 1 lb. to 2 lb. each, and is left in that condition for many days to "ripen." It often happens, when the weather is hot and damp, that the cakes become covered with mould; but this does not seem to produce any ill effect. While one set of workmen manufacture the paste, another set fashion it into the familiar forms met with in commerce. The latter sit at a bench, with a small brazier beneath; the workman warms a piece of the paste, kneads it vigorously in his hands, presses it into a mould, and places the latter under a long lever, on the end of which he sits, so as to compress the ink forcibly for some seconds; he fills another mould in the meantime, and so the operation progresses. The moulds are made of wood, the characters to be impressed upon the cakes being engraved also on wooden dies. One of these dies is dropped into a cavity in the bottom of the mould, while another is laid on the top of the paste in the mould. Common qualities are often pressed into large moulds with several partitions, so that the cakes, when dry, can easily be broken off from each other. For wholesale manufacturing purposes, the best is simply rolled, and the sticks, perforated at one end, are strung together in bunches of ½ doz. to 1 doz. The drying of the cakes occupies 5 to 6 days, according to the temperature. Their high polish is due to brushing over with a hard brush impregnated with tree-wax (probably that secreted by *Coccus Pe-la*, on the branches of *Fraxinus chinensis*), which has the additional effect of preventing the ink soiling the hands when they are moist. The peculiar odour possessed by the finest ink is produced by mixing a small quantity of musk, or of Borneo camphor, with the paste while hot. The common qualities are unscented. The Japanese make ink in the same way, but it is inferior to the Chinese product, as, though the glue and gelatine are equally good, less care is taken in the preparation of the lamp-black. The finest ink should be slightly brown in tint; when quite black, bluish, or grey, it is inferior. A stick of fine ink gives a clear, sharp sound when struck; if the tone be dull, the ink is not homogeneous. The heaviest ink is the best; it improves in colour and brilliancy by age. The chief test of good ink is that it will produce a tint of any depth, without the slightest appearance of irregularity. Some cakes are worth 5s. to 6s. each.

B. There are several cheaper home-made imitations of the Chinese ink, besides some recipes for improving the qualities of the latter. They are chiefly as follows:—(*a*) To improve Indian ink for drawing, so that even the thickest lines will quickly dry, add 1 part of carbolic acid to 80 of the ink. If, by mistake, too much has been added, it may be rectified by putting in more Indian ink. If the mixture is properly performed, the ink is as easy to draw with as it is without carbolic acid, but dries quickly, and may even be varnished without discharging. (*b*) For making a deep-black Indian ink, which will also give neutral tints in its half shades, rub thoroughly together 8 parts lamp-black, 64 parts water, and 4 parts finely-pulverised indigo. Boil the mixture until most of the water has evaporated; then add 5 parts gum-arabic, 2 parts glue, and 1 part extract of chicory. Boil the mixture again till it has thickened to a paste; then shape it in wooden moulds which have been rubbed with olive or almond oil. (*c*) Most of the black Indian ink met with in commerce possesses the disadvantage that it blots when a damp brush is passed over it; or, as draughtsmen say, "it does not stand." The addition of alum does but little good; but bichromate of potash accomplishes the object by rendering insoluble the glue which the ink contains, and thus making the ink permanent. The bichromate of potash possesses a deep yellow (almost red) colour, but does not at all injure the shade of the ink, as 1 per cent. of it in a very fine powder, intimately mixed with the ink, is sufficient. The bichromate must always be mixed with the ink in a dry state, otherwise the latter might lose its friability in water. A drawing which has been made with this ink in the dark, or by artificial light, must be exposed to sunlight for a few minutes, which renders the bichromated glue insoluble in water. Draughtsmen who cannot provide themselves with such ink, make use of a dilute solution of bichromate of potash in rubbing up the ink. There is no danger of the yellow penetrating the paper if the ink is thick enough. (*d*) A substance much of the same nature and applicable to the same purpose as Indian ink may be formed in the following manner:—Convert 3 oz. isinglass into size by dissolving it over a fire in 6 oz. soft water; dissolve 1 oz. Spanish liquorice in 2 oz. soft water in another vessel over a fire; grind up on a slab with a heavy muller, 1 oz. ivory-black with the liquorice mixture; add this compound to the isinglass size while hot, and stir well together till thoroughly incorporated. Evaporate away the water, and then cast the remaining composition in a leaden mould slightly oiled, or make it up in any other convenient way. This composition will be found quite as good as the genuine article. The isinglass size mixed with the colours work well with the brush. The liquorice renders it easily dissolvable on the rubbing up with water, to which the isinglass alone would be somewhat reluctant; it also prevents it cracking and peeling off from the ground on which it is laid. (*e*) Dissolve horn shavings with caustic alkali; boil the brown liquid in an iron kettle till it is thick; pour on double its weight of boiling water, and precipitate by dissolved alum; dry, grind, mix it with gum-water, and pour it into a mould; add perfume if desired. (*f*) Horse-beans, perfectly calcined, are ground to a fine powder, made into a paste with solution of gum-arabic, and then formed into cakes. (*g*) Mix finest lampblack with a solution of 100 gr. lac and 20 gr. borax in 4 oz. water. (*h*) Grind the finest lampblack to a paste with very weak solution of potash. It is then diffused through water rendered slightly alkaline; collected, washed with clean water, and dried. The dry powder is levigated to a smooth, stiff paste with a strong filtered decoction of carrageen (Irish moss), or of quince seed. A few drops of essence of musk, and about half as much essence of ambergris, is added by way of perfume towards the end of the operation; after which it is moulded into cakes, and ornamented with Chinese characters and devices as soon as they are dry and hard. (*i*) A good Indian ink may be made from the fine soot from the flame of a lamp or candle, received and collected by holding a plate over it. Mix this with the size of parchment, and it will be found to give a good deep colour. Burnt rice has been by some considered a principal ingredient in the genuine Indian ink, with the addition of perfumes or other substances not essential to its qualities as an ink. (*j*) Dr. Precht gives an easy method for rendering drawings in Indian ink insensible to water, and thus preventing the ink from running when the drawing has to be coloured and the lines are very thick. To the water in which the ink has to be rubbed is added a weak solution of potash bichromate of about 2 per cent. The animal gum contained in the Indian ink combines with the bichrome, and becomes insoluble under the influence of light. (*k*) Dr. Aug. Chevreuse has discovered that when the common cockchafer (*Melolontha vulgaris*) is decapitated an hour after feeding, each insect yields 4 or 5 drops of colouring matter, varying in hue with the leaves that have served as food. Dr. Chevreuse has thus obtained 14 different tints. Nichlés, professor of chemistry, Preclaire, professor of design, and Chatelain, architect, report that the colour may be used for mechanical and other drawings in place of Indian ink, sepia, &c., and that it is unaffected by exposure to the light or admixture with water-colours. The fluid is collected on strips of glass or shells. For use it is only necessary to dissolve it in water. Laid on in a thick coat, it serves as a varnish. Two or three insects supply colouring matter sufficient, when suitably diluted with water, for the execution of a small landscape. (*Bull. des Sci. et Arts de Poligny.*) (*l*) Calcined lampblack, 100 oz.; boghead shale black, in impalpable powder, 50 oz; indigo carmine, in cakes, 10 oz.; carmine lake, 5 oz.; gum-arabic (first quality), 10 oz.; purified oxgall, 20 oz.; alcoholic extract of musk, 5 oz. The gum is dissolved in 50 to 60 oz. of pure water, and the solution is filtered through a cloth. The indigo carmine, lake, lampblack, and shale black, are incorporated with this liquor, and the whole is ground upon a slab with a muller in the same manner as ordinary colours; but in this case the grinding takes much longer. When the paste is thoroughly homogeneous, the oxgall is gradually added, and then the alcoholic extract of musk. The more the black is ground the finer it is. The black is then allowed to dry in the air, until it has acquired sufficient consistency to be moulded into cakes, which in their turn are still further dried in the air, out of the reach of dust. When quite firm, these cakes are compressed in bronze moulds, having appropriate designs engraved upon them. The moulded ink is then wrapped in tinfoil, with a second envelope of gilt paper. The ink which has been prepared in this manner possesses all the properties of the real Chinese article. Its grain is smooth, it flows very well, mixes perfectly with many other colours, and becomes so firmly fixed to the paper, that other colours may be spread over it without washing it out. (Riffault.)

Invisible or Sympathetic Ink. — The terms "invisible" and "sympathetic" are applied to any writing fluid which leaves no visible trace of the writing on the paper, until developed by the application of heat or chemical reagents. They have been suggested (*somewhat impractically it must be owned*) for use on post-cards. They are principally as follows:—(*a*) Solution of sugar of lead in pure water leaves no trace of writing when dry; the written characters held over a jet of sulphuretted hydrogen are developed of an intense black colour. (*b*) Nitrate of the deutoxide of copper in weak solution gives an invisible writing, which becomes red by heating. (*c*) Chloride of copper in very dilute solution is invisible till heated. To make it, dissolve equal parts of blue vitriol and sal-ammoniac in water. (*d*) Nitrate of nickel and chloride of nickel in weak solution form an invisible ink, which becomes green by heating, when the salt contains traces of cobalt, which usually is the case; when pure, it becomes yellow. (*e*) Chloride of cobalt in properly-diluted solution (25 gr. to the oz.) will produce a pink writing, which will disappear when thoroughly dry, become green when heated, disappear when cold, and pink again when damp. When often or strongly heated, it will at last become brown-red. (*f*) When the solution of acetate of protoxide of cobalt contains nickel or iron, the writing made by it will become green when heated; when it is pure and free from these metals, it becomes blue. (*g*) Bromide of copper gives a perfectly invisible writing, which appears very promptly by a slight heating, and disappears perfectly by cooling. To prepare it, take 1 part bromide of potassium, 1 part blue vitriol, 8 parts water. It is better also to discolour the blue vitriol with 1 part alcohol. (*h*) Write with a solution of paraffin in benzol. When the solvent has evaporated, the paraffin is invisible, but becomes visible on being dusted with lampblack or powdered graphite, or smoking over a candle-flame. (*i*) Writing with iodide of potash and starch becomes blue by the least trace of acid vapours in the atmosphere, or by the presence of ozone. To make it, boil starch, and add a small quantity of iodide of potassium in solution. (*j*) Sulphate of copper in very dilute solution will produce an invisible writing, which will turn light-blue by vapours of ammonia. (*k*) Soluble compounds of antimony will become red by sulphide of hydrogen vapour. (*l*) Soluble compounds of arsenic and of peroxide of tin will become yellow by the same vapour. (*m*) An acid solution of chloride of iron is diluted till the writing is invisible when dry. This writing has the remarkable property of becoming red by sulpho-cyanide vapours (arising from the action of sulphuric acid on sulpho-cyanide of potassium in a long-necked flask), and it disappears by ammonia, and may alternately be made to appear and disappear by these two vapours. (*n*) Writing executed with rice-water is invisible when dry, but the characters become blue by the application of iodine. This ink was much employed during the Indian Mutiny. (*o*) Characters written with an aqueous solution of iodide of starch disappear in about 4 weeks. (*p*) Dissolve 1 fl. oz. common oil of vitriol (sulphuric acid) in 1 pint soft water; stir well, and allow to cool. Write with a clean steel pen; when dry, the writing is invisible; held to the fire, it becomes indelibly black. (*q*) Writing executed with a clean quill pen dipped in onion or turnip juice is invisible when dry; when the paper is heated, the characters assume a brown colour. (*r*) Milk makes a good invisible ink, and butter-milk answers the purpose better. It will not show if written with a clean new pen, and ironing with a hot flat-iron is the best way of showing it up. All invisible inks will show on glazed paper; therefore unglazed paper should be used. (*s*) Boil nutgalls in aquavitæ; put some Roman vitriol and sal-ammoniac to it, and when cold dissolve a little gum-arabic, and it will, when written with, vanish in 24 hours. (*t*) Burn flax so that it may be rather mouldered than burned to ashes, then grind it with a muller on a stone, putting a little aquavitæ to it, then mix it with a little weak gum-water, and what you write, though it seem fair, may be rubbed or washed out. (*u*) Widemann communicates a new method of making an invisible ink to *Die Natur*. To make the writing or drawing which has been made upon paper with the ink appear, it is sufficient to dip it into water. On drying, the traces disappear again, and reappear by each succeeding immersion. The ink is made by intimately mixing linseed-oil, 1 part; water of ammonia, 20; water, 100. The mixture must be agitated each time before the pen is dipped into it, as a little of the oil may separate and float on top, which would, of course, leave an oily stain upon the paper.

Marking-ink.—The use of marking-ink is for writing on textile fabrics; it must therefore be proof against the action of hot water, soap, alkalies, &c. The chief recipes are:—(*a*) 20 parts potash are dissolved in boiling water, 10 parts finely-cut leather-chips, and 5 parts flowers of sulphur are added, and the whole is heated in an iron kettle until it is evaporated to dryness. Then the heat is continued until the mass becomes soft, care being taken that it does not ignite. The pot is now removed from the fire, and water is added; the solution is strained, and preserved in bottles. This ink flows easily from the pen. (*b*) Triturate 1·75 dr. aniline black with 240 drops strong hydrochloric acid and 42 dr. strong alcohol. The mixture is diluted with a hot solution of 2·5 dr. gum-arabic in 170 dr. water. This ink does not attack steel pens, and is destroyed neither by mineral acids nor by caustic alkalies. (*c*) Neutralise 75 gr. carbonate of ammonia with pure nitric acid, and triturate 45 to 60 gr. carmine with the solution. Mordant the fabric with a mixed solution of acetate of alumina and tin salt, and write upon it, when it is perfectly dry, with the ink. The characters will be of a Tyrian purple colour. (*d*) Dissolve in 60 dr. water, 8·25 dr. crystalline chloride of copper, 10·65 dr. chlorate of soda, and 5·35 dr. chloride of ammonium; dissolve 20 dr. hydrochlorate of aniline in 30 dr. distilled water, and add 20 dr. solution of gum-arabic (1 part gum to 2 water), and 10 dr. glycerine; 4 parts of the aniline liquid mixed in the cold with 1 part of the copper solution produce a greenish liquid, which may be used at once for marking linen; but as it decomposes in a few days, it is better to preserve the two solutions separately. The writing is at first greenish, but is blackened by exposure to steam (for example, by being held over the spout of a boiling kettle). A dry heat renders the tissue brittle. (*e*) First mix 1 lb. extract of logwood with 1 gal. water; then dissolve 4 oz. sulphate of protoxide of iron in 4 oz. water; and ½ oz. sulphide of potassium in 2 oz. water. Dissolve the logwood extract by boiling; add the potassium solution to the iron solution, until the latter assumes a black colour; then add this to the logwood solution, and boil for a few minutes. Add ½ oz. cyanide of potassium, to fix the colour; then gum and alcohol. (*f*) An excellent marking-ink is made from the resinous juice of "marking-nuts," the fruit of an East Indian tree (*Semecarpus Anacardium*). The "nuts" are coarsely crushed, then digested for some time in petroleum ether; the solvent is finally allowed to evaporate spontaneously. The syrupy residue, when used for marking, gives a brown mark, which changes to black on applying ammonia or calcic hydrate. The marks resist chloride of lime, acids, and potassium cyanide. (*g*) First moisten the place where the letters are to be written with a solution of 1 dr. carbonate of soda and 1 dr. gum-arabic in ½ oz. water, and smooth the spot with a warm iron. Next, with a quill pen write with a solution of 1 dr. bichloride platinum in 2 oz. water. Lastly, when the writing is dry, write over the letters only with a solution of 1 dr. protochloride of tin in 2 oz. water. The marks immediately acquire a bright purple colour. (*h*) A quicker but more expensive method is to write with a solution of chloride of gold on the linen, previously starched and pressed; on exposure to sunlight the letters assume a bright rose-pink colour. (*i*) When a stencil-plate is used, apply with the brush a mixture of Chinese vermilion with thin copal varnish. The letters will appear red. (*j*) 22 parts carbonate of soda are dissolved in 25 parts distilled water; also 17 parts nitrate of silver in 42 parts ammonia; 20 parts gum are then macerated into 60 parts water, and mixed with the soda solution; the nitrate of silver solution is then added, together with 33 parts sulphate of copper. The ink writes a rich blue. (*k*) Dissolve 1 dr. nitrate of silver in ¾ oz. water; add to solution as much liquid ammonia as will redissolve the precipitated oxide, with some sap green to colour it, and sufficient gum water to raise the volume to 1 oz. Letters written with this ink should be first fire-heated, and then exposed to the sun to blacken. The fabric requires no previous preparation. (*l*) Write with a solution of nitrate of silver thickened with gum and tinted with green, on fabrics previously damped with solution of carbonate of soda. (*m*) Dissolve separately 1 oz. nitrate of silver and 1½ oz. carbonate of soda; mix the solutions, and collect the precipitate on a filter; wash well; introduce the moist precipitate into a mortar, and add 8 scr. tartaric acid; triturate till effervescence ceases; add sufficient strong liquor ammoniæ to dissolve the tartrate of silver; add 4 fl. dr. orchil, 4 dr. powdered white sugar, and 12 dr. powdered gum-arabic; make up to 6 fl. oz. with distilled water. (*n*) Crimson marking-ink may be made by adding 6 gr. carmine to the liquor ammoniæ of (*m*); but it soon loses its crimson tint, and becomes black. (*o*) Dissolve 25 gr. powdered gum copal in 200 gr. lavender oil, by the aid of gentle heat; then add 2½ gr. lamp-black, and ½ gr. powdered indigo. (*p*) In 18 oz. water boil 2 oz. shellac, and 1 oz. borax; when cold, filter; add 1 oz. gum-arabic dissolved in 2 oz. water, with the requisite quantity of indigo and lamp-black. (*q*) First dissolve together 8·5 parts chloride of copper, 10·6 parts salt, and 5·3 parts sal-ammoniac, in 60 parts distilled water; then dissolve 20 parts hydrochloride of aniline in 30 parts water, to which has been added 20 parts of a gum solution (made by dissolving 1 part gum in 2 parts water), and lastly, add 10 parts glycerine. These solutions are kept in separate bottles. For use, mix 1 part by bulk of the first solution with 4 parts by bulk of the second. Apply with a quill pen or small brush. The writing appears green at first, but blackens on exposure to a higher temperature. A steel pen may be used for writing with it. If the cloth, after being marked, is put into tepid soap-suds, the writing acquires a fine bluish tint. The ink should be perfectly limpid, so as to penetrate the fabric; and the solutions should be mixed only when they are to be used. (*r*) Enough finely-powdered cinnabar to form a moderately thick liquid is very intimately mixed with egg-albumen, previously diluted with an equal bulk of water, beaten to a froth, and filtered through fine linen. Marks formed on cloth with this liquid by means of a quill are fixed after they have become dry by pressing the cloth on the other side with a hot iron. (s) The following recipe produces a marking-ink that is quite indelible, and may be applied to the calico with a printing-machine:—Heat 9 parts Venice turpentine with 4 parts olein until well incorporated. Place 10 parts soft potash soap on a slab, and work in the turpentine mixture. Now add 6 parts lampblack (previously ground and sifted), mix well, and finally add 1 part neutral extract of indigo. (*t*) Dissolve 30 gr. of nitrate of silver in 1 oz. of water; add to this 15 gr. of powdered gum-arabic, and 5 or 6 drops of Tarling's red ink; shake well, keep in a stoppered bottle away from the light, and write with a quill pen. After writing, expose it to light for a short time until it becomes nice and black. (*u*) The following is a recipe for an indelible red ink to use with stamps on linen:—Liquefy 1 pint of balsam of capivi by aid of heat, and gradually stir in 2 oz. of thoroughly dry white curd soap cut in thin shavings, and stir until properly diffused. Then introduce a sufficient quantity of vermilion, and stir occasionally until cold. (*v*) Albert Smith, of Essex Road, makes a marking-ink which can be used with any pen, does not require heating, and will not injure the most delicate fabric. The ink writes with a green tinge, and turns an intense black on the first washing. Smith says that the ink cannot be removed by any known chemical means—chloride of lime, cyanide of potassium, caustic soda, and potash having no effect upon it. (*w*) Marking-ink for parcels:—Dissolve asphaltum, grahamite, albertite, or any minerals of this character in naphtha or oil of turpentine to a thin fluid. It dries quickly, does not spread, and the markings are nearly indestructible. (*x*) A bag marking-ink that will stand good, even when bags filled with chemical manures have been in rain and sunshine over 10 days:—1 lb. of logwood chips boiled in 1 gal. of water 10 minutes; then stir in ⅕ oz. of bichromate of potash, and boil this 10 minutes longer; then add, when cold, ½ lb. common gum, previously dissolved, and stir well in. This will flow well from the pen, and will mark bags with either the stencil plate or block. The cost of above ink is about 6*d.* per. gal.

Miscellaneous Inks.—(*A.*) Inks for writing on metallic surfaces may be made as follows:—(*a*) 1 part verdigris (acetate of copper), 1 part sal-ammoniac, ½ part soot, 10 parts water; stir well; write with a quill. (*b*) 1 gr. sulphate of copper dissolved in 20 gr. water; add 2 drops hydrochloric acid, and enough solution of gum-arabic to make the ink adhesive. To make the writing appear at once, add a little pyrogallic acid. Write with a copper pen. (*c*) Dissolve 2 oz. shellac in 1 pint alcohol, filter through chalk, and mix with finest lampblack; forms a jet-black lustreless ink, insoluble in water. (*d*) Take ¼ lb. of nitric acid and 1 oz. muriatic acid. Mix and shake well together, and then it is ready for use. Cover the place you wish to mark with melted beeswax; when cold, write your inscription plainly in the wax clear to the metal with a sharp instrument. Then apply the mixed acids with a feather, carefully filling each letter. Let it remain 1 to 10 hours, according to the appearance desired; then wash and remove the wax. (*e*) Make a saturated solution of sulphate of copper in gum-water. Write with a quill pen. When quite dry, give the labels a coat of white hard varnish, the labels being slightly warmed before application. (*f*) Chloride of platinum, ¼ oz.; soft water, 1 pint; to be kept in glass and used with a quill pen. (*g*) Verdigris, sal-ammoniac, and levigated lampblack, of each ½ oz.; common vinegar, ¼ pint; mix thoroughly. (*f*) is the better, but rather expensive; both will do for zinc, iron, or steel.

(*B.*) Gold and silver inks are made as follows:—(*a*) 24 leaves gold, ½ oz.

bronze gold, 30 drops spirits of wine, 30 gr. honey, 4 dr. gum-arabic, 4 oz. rain-water; rub the gold with the honey and gum, and having mixed it with the water, add the spirit. (*b*) 1 part gold, 3 parts aqua regia; mix, and evaporate till all the chlorine is given off; cool, and mix well with ether; thicken with naphtha or essential oils. (*c*) For gold ink it is best to employ genuine gold-leaf, but owing to the expense this is seldom used; sometimes mosaic gold (sulphide of tin) or iodide of lead is employed, but almost always Dutch leaf. Owing to the relatively low price of silver, genuine silver-foil is used for silver ink; false silver-foil is seldom used, and is not so good. For other metallic inks, commercial bronze powders are employed. The genuine and false foils are also sold in a finely-pulverized state; they are made from the waste of the gold-beaters by rubbing it in metallic sieves to an impalpable powder. In consequence of the beating between gold-beaters' skin, it has particles of grease and other impurities attached to it, which must be removed before it can be used for ink. For this purpose, the whole sheets, or the commercial bronze powder, are triturated with a little honey to a thin magma on a glass or porphyry plate with a pestle, as carefully as possible, as the beauty of the ink depends essentially on this. The finely-rubbed paste is rinsed into a thin glass beaker, boiled for a long time with water containing a little alkali, frequently stirred, decanted, well washed with hot water, and dried at a gentle heat. By boiling this powder with water containing sulphuric, nitric, or hydrochloric acid, different shades can be imparted. Next, a solution of 1 part of white gum-arabic in 4 parts of distilled water is mixed with 1 part of potash water glass, and triturated with the requisite quantity of purified metallic powder. Gold ink will bear more liquid than silver ink, since gold covers much better; on rough paper, more metal is necessary than on sized paper; on light paper, more than on dark, to make the colour of the ink appear equally intense. In general 1 part of foil is enough for 3 or 4 parts of the above liquid. In preparing large quantities of ink, a low porcelain measure is used for transferring it to the small glass vessels where it is to be kept, and it must be continually and thoroughly stirred so that it will always keep well mixed. It requires frequent stirring also when in use. It is best to mix the dry powder with the liquid immediately before using. The ink can be used with a common steel pen, and flows very well when writing slowly, but it is better to use a pencil. The use of potash water glass is of much importance. It greatly increases the metallic lustre on paper, prevents its looking dead, protects the writing from being discoloured by the action of the atmosphere, and prevents its penetrating too far into the pores of the paper, without rendering it very viscid. Although the writing of itself possesses a high metallic lustre, it may be increased by gently polishing with a polishing steel. Inks made with mosaic gold, mosaic silver, iodide of lead, &c., are not nearly so beautiful. (C. H. Viedt.)

(*C.*) Inks for Writing on Glass.—(*a*) A solution of hydrofluoric acid applied to glass previously coated with wax, and the matter scratched through with a style. (*b*) 3 parts barium sulphate, 1 part ammonium fluoride, and sufficient sulphuric acid to decompose the ammonium fluoride and make the mixture of a semi-fluid consistence. It should be prepared in a leaden dish, and kept in a gutta-percha or leaden bottle.

(*D.*) Burnishing Ink.—4 oz. shellac, 1 oz. borax, sufficient water. Boil to the consistence of syrup, and add a few drops of strong ammonia water. A small amount of soap is sometimes also introduced. Add a sufficient quantity of this to the ink to obtain the desired result. Instead of the above, soap is often used alone, or with a trace of glycerine, ammonia, or gum-arabic.

(*E.*) Shoe-finishers'—Make a strong decoction of logwood, preferably in soft water, by boiling; then add green vitriol at the rate of 2 oz. to the gal., with ½ oz each bichromate of potash and gum-arabic. Powder the last 3 ingredients, and even the logwood if you like, as it will take the colour out quicker; or you can use the prepared extract of logwood at the rate of 1 oz. to a gal. of water.

(*F.*) Bookbinders' Ink.—A very good red ink may be made in the following manner:—Infuse $\frac{1}{4}$ lb. of Brazil-wood raspings in vinegar for two or three days. Boil the infusion gently for an hour, and filter it while hot. Put it again over the fire and dissolve in it, first, $\frac{1}{2}$ oz. of gum-arabic, and afterwards of alum and white sugar, each $\frac{1}{2}$ oz. A little alum will improve the colour. The blue is a solution of indigo or Prussian blue.

(*G.*) Obliterated Ink.—(*a*) Wash in warm water to remove salt if the paper has been immersed in sea-water, and then soak in a weak solution of gallic acid, say 3 gr. to the oz. (*b*) Wash in clean water and soak in solution of proto-sulphate of iron, 10 gr. to the oz. (*c*) Apply a solution of potassium ferrocyanide with a brush, when the writing will appear in blue, if any iron is left of the original ink.

(*H.*) Falsified Writing.—Gobert has found that if writing is ever so carefully scratched out, there are still left sufficient traces of the oxide of iron in the ink to become visible in a photographic copy. Light reflected from paper that has not been written on acts in a different way on the photographic materials from that reflected from places which have been *once* covered with ink. By this means the genuineness or otherwise of a document can always be ascertained. (Stummer's *Ingenieur.*)

Printing-ink.—The ink used by printers is compounded mainly of two ingredients, colouring matter and varnish. The former varies according to the quality and tint of the ink; the latter may be obtained by natural resinous substances, or by mixing oil, rosin, and soap.

(*A*). Black.—(*a*) The chief colouring matter in black printing-ink is vegetable lampblack. The price of the best qualities precludes their use except for specially fine ink; nevertheless, good ink cannot be made with inferior samples. An undue proportion of lampblack in the ink will cause it to smear, however long it may have been printed, and to "set-off" during bookbinding operations. Thus the thickest inks are not the best, if the lamp-black is more than the varnish can bind. Ivory-black is too heavy to be used alone; but a proportion ground up with the other ingredients makes a valuable ink for producing the best possible effect with wood-engravings. Only the best and blackest is admissible. Prussian blue, ground exceedingly fine, and used sparingly, deepens the colour of ink; in excess, it gives a cold appearance. Indigo may replace Prussian blue. Perhaps the blackest tint is produced by equal quantities of each. To give a rich tone, and remove the coldness caused by indigo and Prussian blue, the addition of a little Indian red is strongly recommended.

The natural resinous substances employed as a source of varnish are balsam of copaiba and Canada balsam. The former is superior, and when old and pure may be used without any preparation. The latter is much thicker and dries more quickly, and cannot therefore be used alone: but for a strong ink, a small proportion may with advantage be added either to the balsam of copaiba or to the artificial varnish now to be described.

The basis of the artificial varnish is linseed-oil, which should be as old as possible. Of all other oils, the only one recommended as a substitute is nut-oil. The rosin used may be either black or amber. It melts in the boiling oil, and combines with it, preventing its separation from the colouring matter and staining of the paper, and binding the ink to prevent its smearing. The properties possessed by soap, which render it such an indispensable ingredient of printing-ink, are that it causes the ink (1) to adhere uniformly to the face of the type, (2) to coat it completely with the smallest quantity, (3) to leave the face of the type clean, and attach itself to the surface of the damp paper by the action of pressure, and that repeatedly, (4) to wash easily off the type, and (5) to never skin over, however long it may be kept. For all dark inks, well-dried yellow or turpentine soap may be employed; for light-tinted inks, curd soap is preferable. Used in excess, soap tends (1) to render the colour unequal, where a large surface is printed, (2) to spread over the edges of the type, so as to give them a rough appearance, and (3) to prevent the ink drying quickly, and cause it to "set off" when pressed. It is thus opposed to the binding quality of the rosin. Its due proportion is when the ink works clean, without clogging.

The combination of these several ingredients is effected in the following manner:—Into an iron vessel having 2 to 3 times the capacity of the materials it is to receive, put 6 qt. linseed-oil, and make a fire under it. After a time, the oil simmers and bubbles up, but as the temperature increases the surface resumes placidity; next it commences to smoke, and then to boil, emitting a very strong odour; as the boiling continues, a scum arises. At this stage, repeated tests should be made to ascertain whether the escaping vapours will ignite. At the moment when they will do so, the pot is removed from the fire and placed on the ground, and the contents are stirred with an iron spatula, and kept burning. The pot is covered occasionally to extinguish the flame, while samples are withdrawn to test the consistence. When drops of the oil let fall upon a porcelain surface will draw out into strings about ½ in. long, the oil is suited for ink for ordinary book-work. The flame is then extinguished by firmly replacing the cover. On removing it, there is a great escape of strong-smelling smoke, and much froth; the latter is made to subside by thorough stirring, and when this is accomplished, but not before, 6 lb. of amber or black rosin is gradually introduced and stirred in. When the rosin is dissolved, 1¾ lb. of dry brown or turpentine soap, in slices, is stirred in gradually and cautiously, as it froths copiously. When all the soap is in, and the frothing has ceased, the pot is returned to the fire till its contents boil, constant stirring being maintained. This completes the varnish. Into an earthenware pot, or a tub, of sufficient capacity, is put 5 oz. of Prussian blue or indigo, or the two combined; then 4 lb. of the best "mineral lampblack," and 3½ lb. of good lampblack; next add the varnish by degrees while warm, stirring meantime and until all the ingredients are thoroughly mixed; finally pass it through a levigating mill, or between the stone and muller, and reduce it to impalpable fineness. (*b*) A fine, intensely black, strong ink, without the use of oil and rosin, may be made in the following manner:—9 oz. balsam of copaiba, 3 oz. lampblack, 1¼ oz. indigo or Prussian blue, or equal proportions of each, ¾ oz. Indian red, 3 oz. dry turpentine soap, ground between a muller and a stone to impalpable fineness. This is an excellent ink for giving good effect to highly-finished wood-engravings. (*c*) In Germany an ink, prepared as follows, has been used, and is said to yield a very clear and fine impression when properly prepared:—Venice turpentine, 2¼ oz.; soap, in thick paste, 2½ oz.; oleine, rectified, 1 oz.; carbon black, 1¼ oz.; Paris blue, ¼ oz.; oxalic acid, ⅛ oz.; water ¼ oz. The three last ingredients are mixed into a paste. The turpentine and oleine are mixed at a gentle heat, the soap and carbon then introduced, and, after cooling, the blue paste is added, the whole being ground beneath a muller to a very fine and smooth paste. (*d*) Kercher and Ebner's printing-ink is prepared by first dissolving iron in sulphuric, hydrochloric, or acetic acid. Half the solution is oxidized by means of nitric acid, after which the two halves are mixed, and precipitation is produced by the oxide of iron. The precipitate is filtered, washed, and mixed with equal parts of tannic and gallic acid, which produces a black bordering on blue. The black is washed and dried, then mixed with linseed oil, and an ink is obtained suitable for printing, lithography, and wood or metal engraving. (*e*) The base of common printing ink is a linseed-oil varnish, which sometimes possesses a disagreeable odour, and the ink made from it smells so badly as to make a freshly-printed paper an unpleasant companion for sensitive nostrils. Dr. Brackenbusch, of Berlin, proposes to overcome this disadvantage by replacing the linseed varnish with a solution of colophony (rosin) in paraffin oil. He dissolves 45 parts of fine rosin in 25 parts of paraffin oil by heating them to 176° F. (80° C.), or by mixing them with a machine at ordinary temperature. When the solution is effected, if such it may be called, 15 parts of soot or lampblack are added. (*f*) Persoz and Jeanolle make ink for letterpress-printing, lithography, and autography, from the refuse of the gasworks, from other tar, and the heavy oils of petroleum, resin, wood, &c. They say that these substances present valuable qualities for the purpose, that they mix readily with lampblack and other dry colours in powder, and that the ink made from them has the great advantage of neither penetrating the paper nor spreading; and lastly, that it may be mixed in any desired proportions with the fatty oils for certain classes. For black ink for typographic printing, the inventors use what they call evaporated tar, or liquid pitch, with lampblack and Prussian blue, in the following proportions:—Tar, 100 parts; lampblack, 36; Prussian blue, 10; glycerine, 10. (*g*) Colophonic tar, 14 lb.; lampblack, 3 lb.; indigo, 8 oz.; Indian red, 4 oz.; yellow rosin soap, 1 lb. The colophonic tar referred to is the residuum from the distillation of rosin for rosin-oil. (*h*) Linseed-oil, 40 gal.; litharge, 4 lb.; lead acetate, 2 lb. The oil is heated to about 600° F. (316° C.) for 48 to 65 hours, according to quality of varnish required, the lead salts being added as driers. To each gallon of this varnish, 4 lb. of gum copal is added and dissolved. For common news ink, the proportions are as follows:—Of the above varnish, 15 lb.; rosin, 10 lb.; brown rosin soap, 2 lb. lampblack, 5½ lb. (*i*) A fine ink, suitable for use with rubber type, is prepared from soluble nigrosine, 1 oz. pure glycerine, 4½ oz.; white curd soap, ¼ oz.; water, q.s. The nigrosine, finely powdered, is mixed into a stiff paste with the water, hot, and after standing a few hours, this is mixed with the glycerine and soap, and the paste is rubbed down with a muller on a hot stone slab.

(*B.*) COLOURED.—Printing-inks may be made in a number of colours besides black. The principal are the following:—

Blue.—(*a*) Indigo gives a deep but dull blue; it is cold but permanent. (*b*) Prussian blue needs much grinding, and extra soap; it affords a deep bright colour, and is useful for making greens. (*c*) Antwerp blue is easily ground to the proper degree of fineness, makes a good ink, and works clean and well; its tint is bright and light, with a slight green tendency.

Green.—Various shades of green may be produced by suitable admixture of blues and yellows. Prussian blue and chromate of lead make a good rich green; indigo and the same yellow, a deeper, duller colour; Antwerp blue and the same yellow, a brilliant rich green. The chromate must be quite pure to ensure bright colours.

Purple.—Different shades of purple may be made by grinding together carmine or purple lake, with Prussian blue.

Red.—(*a*) Carmine may be readily ground into a fine ink of brilliant colour by admixture with black ink varnish made with balsam of copaiba. It is expensive, but valuable for special purposes. (*b*) Crimson lake is easily reduced by the muller; it works clean, and does not require more soap than is contained in the varnish, but it does not possess much depth. (*c*) A deeper tone than can be obtained from commercial lake may be produced in the following manner:—1 oz. best cochineal, powdered, and boiled in 1 qt. water, till the colouring matter is extracted, let the cochineal subside, and pour the liquid into another vessel; when cold, gradually add some chlorate of tin, with constant stirring, till the supernatant liquid, on standing, becomes nearly colourless; then add a little powdered alum. Assist the solution by stirring; allow to subside; pour off the excess liquid; wash the coloured residue with 3 or 4 waters, to remove the acid; and dry carefully and slowly. The addition of cream of tartar during the process will give a purple tint. (*d*) Vermilion may be used for red ink where neatness is required, as for title-lines *of books*. The *quantity varies* much, and necessitates care in its proportions. It requires much soap to make it work clean. (*e*) For cheap work, such as posting-bills, red-lead may be used it requires additional soap to make it work clean, and its colour soon changes to black. (*f*) An excellent permanent red, of rich tone, may be produced from Indian red. (*g*) Venetian red is easily ground into a smooth ink, and requires but little more soap than the varnish usually contains; it is not very intense. (*h*) 2 oz. mineral orange-red, 1 oz. Chinese vermilion; grind in printers' varnish or oil, as prepared for ordinary printing-ink.

Yellow.—(*a*) The highest yellow is obtained from chromate of lead, which is easily ground into a fine ink, works freely and well, and requires but little soap beyond what the varnish contains. (*b*) Yellow ochre is easily ground into a fine ink; it gives a useful colour, dull, but permanent.

Stamping-inks.—These are intended for use with rubber stamps. (*a*) The ordinary stamping-ink made by diluting printing-ink (which is made of lampblack and linseed varnish) with boiled linseed oil, stands pretty well if enough is used, but when poorly stamped will wash off. Dr. W. Reissig, of Munich, has recently made an ink for cancelling stamps which is totally indelible, and the least trace of it can be detected chemically. It consists of 16 parts of boiled linseed-oil varnish, 6 parts of the finest lampblack, and 2 to 5 parts of iron perchloride. Diluted with ⅛ the quantity of boiled oil varnish, it can be used for a stamp. Of course it can only be used with rubber stamps, for metallic type would be destroyed by the chlorine in the ink. To avoid this, the perchloride of iron may be dissolved in absolute alcohol, and enough pulverized metallic iron added to reduce it to the protochloride, which is rapidly dried and added to the ink. Instead of the chloride, other salts of protoxide or peroxide of iron can be used. The iron unites with the *cellulose and the sizing of the* paper, so that it can easily be detected even after the ink has all been washed off. Sulphide of ammonia is well adapted for its detection. (*b*) A violet ink for rubber stamps is made by mixing and dissolving 2 to 4 dr. aniline violet, 15 oz. alcohol, 15 oz. glycerine. The solution is poured on the cushion and rubbed in with a brush. (*c*) The following is said to be a good ink for use with rubber stamps:—Aniline violet, 90 gr.; boiling rain-water, 1 oz.; to which is added a little glycerine and a small quantity of treacle. The quantities of the last two ingredients will vary with the season, but half a teaspoonful will be ample for the quantities of violet and water specified. (*d*) Red.—Dissolve ¼ oz. of carmine in 2 oz. of strong water of ammonia, and add 1 dr. of glycerine and ¾ oz. of dextrine. (*e*) Blue.—Rub 1 oz. of Prussian blue with enough water to make a perfectly smooth paste; then add 1 oz. of dextrine, incorporate it well, and finally add sufficient water to bring it to the proper consistence. (*f*) For linen and cotton.—Dissolve 1 part of asphaltum in 4 parts of oil of turpentine, and add lampblack, or blacklead, in fine powder, in sufficient quantity to render the ink of a proper consistence for printing with types. (*g*) The cushions or pads generally used in connection with rubber stamps require fresh supplies of ink from time to time; but lately a cushion has been devised which will give off colour "permanently," *i.e.* until it is all used. This consists of a box of wood, or other material, filled with an elastic composition saturated with a suitable colour. The cushion fulfils its purpose for years without the material being renewed, always contains sufficient moisture, which is drawn from the atmosphere, and continues to act as a colour stamp cushion so long as a remnant of the mass or composition remains in the box or receptacle. The composition consists preferably of 1 part gelatine, 1 part water, 6 parts glycerine, and 6 parts colouring matter. The composition can also be made from a mixture of gum with borax, ordinary Chinese glue, and other similar materials. A suitable black colour for the cushion can be made from the following materials; 1 part gelatine glue, 3 parts of lampblack, aniline black, or a suitable quantity of logwood extract, 10 parts glycerine, 1 part absolute alcohol, 2 parts water, 1 part Venetian soap, ⅛ part salicylic acid. For red, blue, or violet—1 part gelatine glue, 2 parts aniline of desired colour, 1 part absolute alcohol, 10 parts glycerine, 1 part Venetian soap, and ⅛ part salicylic acid. For blue—also indigo, ultramarine, cobalt, Prussian or Paris blue. For red—vermilion or carmine; and for green—aniline or other suitable colouring matter.

IODINE.—Iodine is widely distributed in the animal, vegetable, and mineral kingdoms. It is found in sponge and cod-liver oil; in all algæ and marine plants, mainly as potassium iodide; combined with silver, mercury, and lead, as sodium iodide in many kinds of rock-salt, as sodium iodate in the mother liquor from nitrate of soda works, as calcium iodide in the ocean, and in combination with potassium, sodium, magnesium, and calcium in many springs. The commercial sources of iodine are (1) seaweeds, (2) *caliche*, or raw nitrate of soda, (3) Stassfurt salts. Its preparation from these will be described in the order stated.

(1) *From Seaweeds.*—The seaweeds which serve as sources of iodine are met with in the seas washing the coasts of different countries. The shores of Normandy and Brittany, certain coasts of Scotland and Ireland, and many other countries which it is unnecessary to mention here, produce numerous sea-plants containing more or less iodine, bromine, and salts of potash. Our hemisphere does not possess the exclusive privilege of yielding iodiferous plants. Some years ago an examination of about a hundredweight of saline matter from the coast of Patagonia showed that these ashes were as rich in iodine and in potash as good Breton ashes. Among all the kinds of seaweed used in this manufacture, the richest are the two varieties of *Fucus digitatus*, a plant of the deep seas, and which is habitually gathered as drift. Treating plants of this species collected on the north-west coast of Spain, at the southern extremity of the Bay of Biscay, gives very advantageous results. The arrival of the weeds on the coast depends on the season, the height of the tides, and the disturbance of the atmosphere and the sea. In a general manner, it may be said that the chief gathering of the weeds is in winter; that it is best at the time of high water, and especially at the equinoxes. There are various manners of collecting the weeds. When the tide, after high water, begins to ebb, the weeds which it has brought up are left on the shore. They are then collected and washed a little before the water retires too far. They are made up in heaps of ½ to 1 ton, and carried to the works. The process of incineration, named the "trench" process, consists in:—1st, Spreading out the weeds on the sand, or preferably on grass, to dry them. 2nd, Burning in trenches, made in the soil and lined with masonry. This process, among the inconveniences which it presents, has especially the fault of burning the weeds in an irregular manner, calcining one part whilst the rest is imperfectly

burnt, and yielding ashes mixed with much earth and sand. Hence the yield is very irregular, and the iodine very rarely exceeds 3 parts in 1000. Being temporarily entrusted with the management of works where the returns were far from answering to the analytical richness of the weeds, Dr. Thiercelin modified the method of incineration as follows:—Having observed that the species named *Fucus digitatus* is much the most abundant, and at the same time the richest, it was decided to collect this kind only. As he did not make it a prominent point to dry the plant, he resolved to collect it at all seasons, not forgetting that the proportion of iodine varies with the season, so that from May to September not merely much less weed is to be gathered than from September to May, but that collected in summer yields, weight for weight, only the third of that obtained in winter. The weeds being collected, are immediately taken to the furnace-house, weighed, and put in work. The furnace-house is a shed about 60 ft. long by 18 ft. in width. It contains the furnace, a press, pits or holders for the weed, and a space where the ashes produced may be accumulated. The furnace has the form of a long reverberatory, with the fire in front, and behind it a kind of gallery 15 ft. long and 3 ft. broad, with a vault 1 ft. 9 in. in height. The sole of the furnace has a slope of about 12° to the horizon. Upon this furnace follows a drying-floor to utilize the waste heat; and, lastly, a chimney 30 ft. in height. A hole in the shape of a hopper opens at the extremity of the furnace to receive the weeds, and is closed with a plate of sheet-iron. Three side-doors serve for working the weeds gradually forwards to the hottest part of the furnace, above which is placed a boiler to receive liquids for evaporation. If the works are still empty, and if weeds arrive in abundance, one portion of the weed is placed in the pits and allowed to ferment; another portion is spread out on the furnace-top and the drying-floor, and the rest is introduced in the green state into the furnace by the hopper. The charge of green weed is about half a ton, and a little water is put into the boiler against the juice of the weed is ready, to prevent the iron plates from burning. The fire is then kindled, and we obtain—(1) A partial drying of the weeds spread on the furnace-top and on the drying-floor annexed. (2) A more complete desiccation in the interior of the furnace. The weeds are then raked downwards, and as the heat becomes more intense, the dry leaves take fire. When this result is obtained, the hottest parts are drawn into an ash-pit which runs the whole length of the furnace. The combustion which began in the furnace is here completed; it goes on slowly, and is continued by reason of the fresh supplies which are continually thrown upon the first. Whilst room is thus made in the furnace, owing to the desiccation and ignition, fresh quantities of dried weed are introduced through the hopper, taken from the drying-floor and the furnace-top, and green weed is spread out to dry in their place. After the work has once commenced, it never ceases except from lack of weeds. In the meantime the weeds placed in the pits undergo alcoholic fermentation, so that at one time Thiercelin hoped to collect and utilize the alcohol. However, putrid fermentation sets in after 4 or 5 days, and he never found more than 1 per cent. of alcohol in the liquid. After fermentation for 4, 5, or 6 days, the weeds are put under the press, and the juice is thus separated from the cakes. The juice is evaporated to dryness in the boiler above the furnace. The flakes of dried extract are then placed in the furnace beyond the bridge. The press-cakes are placed successively on the drying-floor and in the furnace, and yield ash like the unpressed weed. Is the fermentation necessary? Thiercelin believes that it is at least very useful, since it is said to prevent the formation of a volatile cyanide of iodine, which would occasion a loss of this substance. In any case he had recourse to it only when the stock of weed was too great for the furnace to take up without waiting. If we compare this method with that of incineration in pits, it will be seen—1. That the drying is done away with under circumstances where it is very difficult—on the seashore and in the winter season. 2. That we may substantially count upon getting all the iodine contained in the weeds. Thus, if in the summer we only obtain 5 per 1000, or ½ per cent. of iodine, in winter we get 14 or even 15 per 1000, = 1⅖ or even 1½ per cent., at a time when the yield is greater and when drying would be impracticable. 3. The extraction of iodine and of potash from the light ashes obtained by this process is much easier than from the residues of the common process, which are hard as stones, and require a long time and much hot water for lixiviation. (*Bull. Soc. Chem.*)

At the beginning of the present century, Highland kelp realised 20*l.* to 22*l.* per ton. Those were lucrative days for the Highland proprietors. The small island of Colonsay yielded 200 tons of kelp annually, to the value of about 4000*l.* Long Island yielded 4000 tons, with a net revenue from this source alone, free of all charges, of about 30,000*l.* per annum; the sum paid to the burner being only 35*s.* per ton. The Hebrides afford a very large supply, roughly estimated at 6000 tons annually. Kelp as it comes to Glasgow occurs in large pieces, somewhat resembling iron slag. It is first broken up into pieces the size of ordinary road metal, and lixiviated in vats heated by steam. The liquor thus obtained is evaporated, and the salts which deposit on evaporation are fished out. They consist chiefly of potassium and sodium chlorides, and potash sulphate. After the removal of the mother-liquor from the salts, some manufacturers add to the liquor ¼ of its volume of sulphuric acid, and having agitated the whole, it is left to repose for about 24 hours, during which period the sulphurous compounds are decomposed; sulphates are produced, whilst the sulphides, hydrogen, and sulphurous acid undergo mutual decomposition, and sulphur is thrown down. At the end of this time, the liquor is put into an iron still, which is adapted to a series of stoneware receivers; a quantity of dry binoxide of manganese is added, and the iodine distils over by applying a strong heat. The binoxide of manganese, by acting on the chlorides present, under the influence of the excess of sulphuric acid, liberates chlorine, which in turn displaces the iodine. To obtain iodine pure, it is necessary to subject it to sublimation. The following is the process pursued by one Glasgow firm in the preparation of this article. The kelp is lixiviated in large water vats, and the liquor is boiled down to required strengths, by which the muriates and sulphates of potash and alkaline salts are separated by alternate precipitation and crystallization. The remaining mother-liquor, which possesses a specific gravity of 1·5, contains the soluble iodides, bromides, sulphates, and hyposulphites, and by adding sulphuric acid the latter two are decomposed, and sulphur is precipitated, which may be collected. The clear liquor is then treated with excess of sulphuric acid and black oxide of manganese in retorts, when the iodine distils over and is collected in earthenware receivers. The bromine, which is obtained from the same source as iodine, is subsequently separated by a further addition of manganese, and collected in suitable receivers. The iodine is subsequently subjected to the process of sublimation it necessary. The iodine and bromine may be converted into iodide and bromide of potassium, the two compounds which are chiefly used, by dissolving them in potassium hydrate, eating to decompose the iodate and bromate which are formed, and crystallizing the salts. (Cochrane.)

2. *From Caliche.*—Iodine occurs in *caliche* or raw nitrate deposit, as iodate of sodium, in quantities varying from mere traces to 50 per cent.

The *aqua vieja*, or mother-liquor, of these works contains about—

	Per cent.
Nitrate of sodium, $NaNO_3$ ..	28
Chloride of sodium, $NaCl$ ..	11
Sulphate of sodium, Na_2SO_4 ..	3
Sulphate of magnesium, $MgSO_4$	3
Iodate of sodium, $NaIO_3$ ..	22
Water, H_2O	33

The mother-liquor is conducted through the pipe for mother-water to the precipitators, which are constructed of 2-in. tongued and grooved timber, lined with sheet lead, to prevent leakage by warping and shrinking; they are stayed transversely by ¾-in. bolts. The reagent for precipitating the iodine is the run-off from the tanks for acid deposits in sufficient quantity to precipitate the iodine held in solution, which is determined by measuring previous to precipitation. The wings, or fans, which are also of wood, are then turned by hand until the liquor becomes thoroughly mixed with the acid.

This causes most of the iodine to fall to the bottom of the precipitators in slimes and flakes, and some to rise to the surface as a black froth. The iodine on the surface is skimmed off by large wooden spoons and placed in clarifying tanks, and the mother-liquor is then drawn off to the tank for mother-water after precipitation. Thence it is returned to the nitrate of sodium department, where it is again used, again becomes impregnated with iodine, and again goes through a similar process.

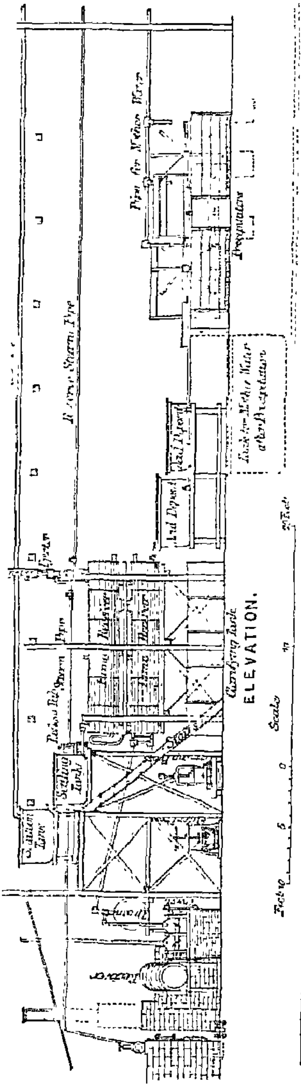
The deposit of iodine left in the bottom of the precipitators is taken out and placed in the clarifying tanks, where it undergoes a series of washings with pure water. It is then filtered and partially dried in a filter press, whence it is taken and pressed in the forming press, and is removed from the movable bottom of the press in blocks of cheese form, 8 in. in diameter by 6 in. thick. The blocks are next placed in a cast-iron retort, to which are attached 8 earthenware receivers, each 3 ft. long by 2 ft. 6 in. diameter. The last or end receiver is stopped by a wooden end and clay joint. The joints of the receivers are also made of clay. When the retort is charged, the crude iodine is sublimed by a slow fire. After sublimation, the retort is allowed to cool, the joints of the receivers are broken, the receivers taken down and emptied, and the contents placed in tarred kegs for exportation.

The crude iodine, previous to sublimation, contains: iodine, 80 to 85 per cent.; non-volatile matter, 6 to 10 per cent.; the remainder being water. The reagent for the precipitation of iodine is the acid sulphite of sodium, $NaHSO_3$, formed by saturating the aqueous solution of "salnatron" (impure carbonate of sodium, Na_2CO_3) with fumes of burning sulphur. "Salnatron" is formed by burning coal-dust with nitrate of sodium, thus: $2NaNO_3 + C = Na_2CO_3 + N_2O_3$. Its impurities consist of chloride and sulphate of sodium, earthy matters, and unburnt coal; the latter are eliminated by dissolving the salnatron in water, and settling.

The fumes from the burning sulphur are generated in a fire-brick oven, and are drawn by an ejector from the oven, to the drainer, which catches the particles of partly burned sulphur, and from the drainer to the cylindrical fume receivers, which are charged with "salnatron" solution, and are traversed with perforated pipes for the passage of the fumes.

The steam for the ejector is taken from a small horizontal boiler at the extremity of the building. The building is well ventilated, and is made of wood and corrugated iron. The apparatus employed is illustrated in Fig. 14. The cost of this plant was 23,000 dollars Chilian currency. During the months of October and November 1881, the author exported from *Iquique* 7560 lb. of sublimed iodine, manufactured by this plant. (R. Harvey, in *Min. Proc. Inst. C.E.*, vol. lxix., session 1881–2, part iii., paper No. 1850.)

The method invented by Thiercelin for use in Chili and Peru is as follows:—The mother-liquors resulting from the manufacture of sodium nitrate are treated with a mixture of sulphurous acid and sulphite of soda, in proper pro-



portions, and the iodine is precipitated as a black powder. The precipitated iodine is put into earthen jars, on the bottom of which there are layers of quartz sand, fine at the top and coarse at the bottom; from this, it is removed by earthen spoons into boxes lined with gypsum, and a great part of the water is thus removed. It is sometimes sold in this impure state, or further purified by sublimation.

IODOFORM.—The following remarks on the various processes for preparing iodoform are abstracted from a paper read by Dr. G. R. Bell before the Massachusetts College of Pharmacy:—

1. Cornélis and Gillé, of Liège, give a method of obtaining iodoform by adding to an alcoholic solution of iodide of potassium, heated to 104° F. (40° C.), hypochlorite of calcium in successive portions, stirring after each addition until the liquid no longer assumes a dark-red colour on the addition of a fresh portion of calcium hypochlorite (which is a sign that the process is completed). It is then allowed to cool, when the iodoform and calcium iodate crystallize out; the mass of crystals are then treated with boiling alcohol of 90 per cent., which dissolves only the iodoform; this is largely deposited on the cooling of the alcohol.

2. Bouchardat, of Paris, recommends the following process:—Put 100 parts iodine in a comparatively long-necked flask or mattrass, add 100 parts bicarbonate of potassium, 1200 parts of distilled water, and 250 parts of alcohol; insert a cork through which passes a long glass tube; heat in a water-bath, not too quickly, to about 176° F. (80° C.); and add, after decoloration of the liquid, 25 parts of iodine; then add 20 and afterwards 10 parts of iodine, waiting with each addition till the liquid has lost its brown colour. If iodine should happen to be a little in excess, add cautiously some solution of potash until decolorized, which shows completion of the process. Now pour the liquid into a porcelain dish, cover, and let stand 24 hours; throw on a filter, and wash the iodoform with cold distilled water. The

iodoform which has separated is now spread on folds of bibulous paper and dried in the open air. Hager recommends to then evaporate the filtrate to dryness, calcine with charcoal, and extract the iodide of potassium with diluted alcohol. As this is quite troublesome to do, Wilder recommends to concentrate the filtrate by evaporation, and decompose the iodide and iodate of potassium with nitric acid in excess, whereby iodine is precipitated as a fine black powder, and washed with water. As to the yield, Hager states the highest obtained by him to be 35 per cent. Wilder did not succeed in getting more than 28 per cent., the regained iodine amounting to 62 per cent., thus leaving 10 per cent. of iodine to be accounted for, which he thinks is partly due to the formation of iodide of ethyl; but he thinks 10 per cent. is too much, and probably to be ascribed to the small quantities he operated upon.

3. Filhol recommends the following process:—Put into a mattrass or flask similar to the one used in Bouchardat's process, a solution of 200 parts crystallized sodium carbonate and 1000 parts of distilled water, and add 100 parts of alcohol; heat in a water-bath at 140° to 160° F. (60° to 71° C.), then gradually add 100 parts of iodine, about 10 parts at a time. When the liquid has become colourless, remove the flask from the water-bath, and allow to cool 3 or 4 hours, then pour out on a filter; return the filtrate to the flask, add 200 parts of carbonate of sodium, 100 parts of alcohol, heat to 160° F. (71° C.), and pass a slow current of chlorine gas through the mixture as long as iodine is separated, continuing until the brown liquid is again decolorized. A small excess of chlorine is of no consequence (Hager states that for every 100 parts of iodine it requires the chlorine which can be evolved from about 200 parts of hydrochloric acid by means of manganese dioxide). Let the flask stand 24 hours, then throw the contents on a filter, and examine the filtrate with chlorine water to see whether it still contains an appreciable amount of iodine compounds; then if necessary subject the filtrate to a second treatment of chlorine gas, adding previously only 20 parts of carbonate of sodium and 10 parts of alcohol. Collect the iodoform after 24 hours. The filtrate may be concentrated, and decomposed by excess of nitric acid, according to the method recommended in Bouchardat's process. The collected crystals of iodoform are now well washed with the smallest quantity of cold distilled water, spread out on pieces of bibulous paper, and dried in the open air. Respecting the yield, Hager says that with the utmost accuracy he did not obtain higher than 72 per cent. in two different operations he made. Wilder succeeded in getting 42 per cent. and 53 per cent., the regained iodine amounting to 40 per cent. and 35 per cent., thus leaving 18 per cent. and 12 per cent. unaccounted for. He makes the same remarks in regard to the iodine loss as he did in Bouchardat's process, which was that of working with too small quantities, and thinks that in working with proportionally larger quantities the loss will be less.

Bell tried the following experiments to test the different methods that had been proposed for the manufacture of iodoform:—

Experiment No. 1.—Bouchardat's process, as mentioned before. He used a round-bottomed flask, into the neck of which he inserted a cork through which was passed a long glass tube ($\frac{3}{8}$ in. in diameter and 3 ft. long) which acted as an inverted condenser. The flask was placed in a water-bath, and supported so that the tube was held in an upright position, thus condensing all the liquid volatilized, and allowing it to run back in the flask again.

He placed in the flask 5 grm. of iodine, 5 grm. of crystallized bicarbonate of potassium, 60 cc. of water, and 12·5 grm. of alcohol (95 per cent.), and heated in a water-bath between 140° and 176° F. (60° and 80° C.), till the colour had disappeared, when 1·25 grm. of iodine was added, and the flask heated until the colour had disappeared a second time; then 1 grm. of iodine added, and heated until it was decolorized; then 5 grm. of iodine added, and again heated until decolorized. After the third addition of iodine (or 1 grm. lot), he found the crystallized bicarbonate of potassium insufficient to decolorize the solution; he added more of this salt (small portions at a time), until there had been added [illegible] grm., which completely decolorized the mixture.

After the last portion of iodine that had been added was decolorized, the flask was placed aside to cool and to allow the iodoform to separate, when the contents of the flask were thrown on a filter, to separate the iodoform from the mother-liquor. The iodoform was then washed with a small quantity of cold distilled water, placed in folds of bibulous paper, and allowed to dry; it was then weighed, and found to amount to 0·850 grm. The product was of a light lemon colour, and very distinctly crystalline.

Although Bouchardat does not speak of treating the mother-liquor for a further separation of iodoform, Bell passed a stream of chlorine gas through the mother-liquor (as recommended in Filhol's process), *after the addition of* 5 grm. of bicarbonate of potassium and 12·5 cc. of alcohol, which resulted, not in the separation of iodoform, but in the liberation of violet vapours of iodine; upon adding to the liquid in the flasks a small quantity of solution of potash, there was an instantaneous production of a second quantity of iodoform, which was separated by filtration, washed, dried, and weighed. It amounted to 0·489 grm. The total amount of iodoform obtained by both separations was 1·339 grm., or 17·27 per cent. No attempt was made to obtain the iodine from the mother-liquor, for reasons that will be mentioned below.

Experiment No. 2.—Filhol's process (as described above). Bell placed in a flask, arranged as in the preceding experiment, 2 grm. of iodine, 10 grm. of crystallized carbonate of sodium, 50 cc. of water, and 5 grm. of alcohol, and heated in a water-bath, between 140° and 160° F. (60° and 80° C.) till the liquid was decolorized, when he added 2 grm. more of iodine, and again heated till decolorized. He then added 1 grm. of iodine, and continued heating until decolorized, never allowing *the temperature to rise above* 160° F. (80° C.). The flask was then removed from the water-bath and allowed to cool, when a large quantity of iodoform of a deep yellow cast crystallized out.

The contents of the flask were then thrown upon a filter; the iodoform was washed with a small quantity of distilled water to free it from the mother-liquor, and placed on folds of bibulous paper in a warm atmosphere to dry. The dry product weighed 0·834 grm.

The filtrate from this (the first separation) he returned to the flask, and added 10 grm. of crystallized carbonate of sodium, 0·5 grm. of alcohol heated to 140° F. (60° C.), and passed a slow current of chlorine gas through the mixture, which at first assumed a brown colour, then was decolorized with a separation of iodoform. The current of gas was then stopped, the flask removed from the water-bath, and allowed to cool.

The contents of the flask were then thrown upon a filter, washed, and allowed to dry. The precipitate before washing was very bulky and of a very light colour (almost white), due to the presence of iodate of sodium, which had separated in a non-crystalline condition. The dry product from this (the second separation) weighed 0·456 grm. He returned the filtrate from the second separation to the flask, and added 5 grm. of alcohol, 1 grm. of crystallized carbonate of sodium, heated to about 150° F. (65½° C.), and passed a current of chlorine gas through the mixture, which only caused a liberation of iodine vapours; whereupon he added 1 grm. of crystallized carbonate of sodium and 5 grm. of alcohol, still continuing the current of gas. No change having taken place in the appearance of the liquid, he added a small piece of soda, about 0·5 grm.; the liquid then became colourless, and a separation of iodoform took place. The current of gas was now stopped, the flask removed from the water-bath, allowed to cool, and the contents thrown on a filter and washed. The dry product weighed 0·136 grm. The amount of iodoform obtained from the three separations was 1·426 grm., or 28·5 per cent.

Experiment No. 3.—Filhol's process. This experiment is virtually a repetition of No. 2, with the exception of using three times the quantity. He placed in a flask a mixture of 30 grm. of crystallized carbonate of sodium, 150 cc. of water, 15 grm. of alcohol (95 per cent.), and 15 grm. of iodine, heated in a water-bath, between 140° and 160° F. (60° and 80° C.), till decolorized, when iodoform was separated of a lemon-yellow colour, which, when filtered, washed, and dried, weighed 2·914 grm. He returned the filtrate to the flask, added 30 grm. of crystallized carbonate of sodium, 15 grm. of alcohol, and returned the flask to the water-bath, heated to 150° F. (65½° C.), and passed a current of chlorine gas through the mixture, which, instead of permanently decolorizing the solution, turned it almost colourless, and then changed it to a dark brown colour, whereupon he added 15 cc. of solution of potash (U. S. P.), and continued the current of chlorine gas. The solution became colourless, with a separation of iodoform in a brownish and apparently impure (or possibly in an amorphous) condition. Upon recrystallizing this from alcohol, the iodoform separated in bright yellow crystals. The product, washed and dried, weighed 1·671 grm.

The filtrate from the second separation was returned to the flask, 3 grm. of crystallized carbonate of sodium and 1·5 grm. of alcohol were added, the flask was placed on the water-bath heated to 150° F. (65½° C.), and a current of chlorine gas was passed through, which caused a third separation of iodoform, which was filtered while hot, to separate the iodoform from the iodate of sodium, which is much more soluble in the warm liquid than in cold. The iodate of sodium separated in fine needle-shaped crystals; the iodoform, when dry, weighed 0·868 grm. The total amount of iodoform obtained from the three separations was 5·453 grm., or 36·35 per cent.

Experiment No. 4.—This experiment was simply a repetition of Filhol's process, as described above, with this difference, that Bell added to the deodorized alcohol used 1 part of amylic alcohol in 5 parts of alcohol; the iodoform obtained was of a deep yellow colour and of a very disagreeable odour, similar to that of commercial iodoform.

Experiment No. 5.—Cornélis and Gillé process. The results obtained with this were so unsatisfactory that Bell did not save the product. Although the amount of material taken for the experiment was as large as that taken for the other experiments, the yield was very small and of an inferior appearance. He found the other processes so much superior to this one that he did not think it worth while to repeat it.

Criticisms.

Experiment No. 1.—Bouchardat's process. This process is generally recommended as the easiest to work by; in one respect it is, namely, you are not obliged by it to work over your filtrates for additional separations of iodoform by chlorine gas, as in Filhol's process; but it is an objectionable process for the following reasons:—

1. The bicarbonate of potassium used is more expensive than the carbonate of sodium used in Filhol's process.

2. It is a slower process than Filhol's, taking more time to complete the reactions.

3. The yield is not nearly so great as in Filhol's.

Bouchardat says nothing about treating the second filtrate for an additional separation of iodoform, which Bell found possible to do by passing a current of chlorine gas after adding an additional quantity of bicarbonate of potassium, alcohol, and a small quantity of solution of potash, which shows that it is possible to obtain more iodoform from the amount of iodine used than by following Bouchardat's own directions. But even if the second filtrate was treated with chlorine gas, the process would be more expensive than Filhol's, and the yield not so great.

Experiment No. 2.—Filhol's process Bell considers by far the most advantageous one to work by, for the following reasons :—

1. The yield is greater than by any other process tried.

2. It is cheaper.

3. It is a quicker process to work by.

4. The crystals obtained are much handsomer than by the other processes.

For those who wish to obtain an almost odourless iodoform (which they can easily do by using pure materials), Filhol's process is to be recommended, the product having only a faint saffron-like odour.

Experiment No. 5.—The object of this experiment was to find out whether the presence of amylic alcohol would cause the iodoform formed to have a disagreeable odour, in which respect it was successful, the product having a very disagreeable odour, closely resembling that of the commercial article, and when dissolved in alcohol it formed a reddish coloured solution, resembling that obtained by dissolving commercial iodoform exposed to the sunlight.

No attempt was made to recover the iodine from the mother-liquors, because the amount obtained was too small to work to advantage, also because the experiments were tried solely to find out which process would be the best, as regards quality and yield, for the dispensing pharmacist to employ in making iodoform for his own use. It would of course pay to save the mother-liquors until enough was obtained to make it an object to extract the iodine contained in them.

ISINGLASS.—Isinglass, or fish glue, in its raw state, is the "sound," "maw," or swimming-bladder of various kinds of fish. The sounds undergo no other preparation than careful drying, but in the drying they are differently treated and made up, so that the isinglass comes into commerce under the names of "leaf," "staple," "book," "pipe," "lump" "honeycomb" and other designations, according to its form. The finest isinglass, which comes from Russia, is prepared by cutting open the sounds, steeping them in water till the outer membrane separates from the inner, then washing the latter, and exposing it to dry in the air. Russian isinglass is obtained from several species of sturgeon (*Acipenser*), found in the Volga and other tributaries of the Caspian Sea, in the Black Sea, and in the Arctic Ocean. Brazilian isinglass, obtained from Brazil and Guiana, is the produce of a large fish, *Silurus parkerii*, and probably some other species. Manilla and East Indian isinglass is yielded by species of fish not yet satisfactorily determined. The sounds of the common cod, the hake, and other *Gadidæ* are also used as a kind of isinglass. (*Encyc. Brit.*)

The best quality of American isinglass is made from the sounds of the hake. The crude material is collected during the summer and autumn, coming from Maine, New Brunswick, Nova Scotia, and Prince Edward's Island. The conversion of the crude material into the mercantile article takes place in winter. A low temperature is necessary in order to turn out by machinery the fine ribbons of isinglass, and ice-water passes through the rolls. The total product is about 250,000 lb. Besides the use of isinglass for fining beer, &c., it is employed as a dressing or glaze for straw goods in the United States. (*Scient. Amer.*)

The manufacture of isinglass is carried on to a considerable extent in India, principally from the air-vessels of several varieties of acanthopterygian fishes, and particularly different kinds of perch, as well as from other fish. (*Nature.*)

Seaweed Isinglass. — A very interesting product, called *kanten*, or vegetable isinglass— a species of gelose derived from either of the sea-weeds *Gelidium corneum* or *Plocaria lichenoides* —is made in China and Japan, and exported to Europe in flat and moulded tablets and in bundles of strips. It is known in Cochin China as *hai thao*, and is used in France in several industries, especially in the preparation of gold-beaters' skin, and for rendering tissues impermeable. It is soluble in boiling water only, of which it takes up about 500 times its weight. It is manufactured as follows:—The seaweed, called by the native name of *tengusa*, is carefully washed and afterwards boiled, so as to form a gluish decoction, which is strained off and put into square boxes. When cool, it forms a stiff jelly, which can easily be divided into squares a foot in length. The manner in which the surplus water is removed is very ingenious. The jelly prisms are exposed in the open air during a cold night, and allowed to freeze. During the day the sun melts the water, which runs off, leaving behind what one might term the skeleton of white horny substance, which is extremely light and easily dissolved in water; when cooled, it again forms a stiff jelly. This article can be applied to many purposes—for culinary uses, for making bonbons and jellies, for clarifying liquids as a substitute for animal isinglass, for making moulds used by the plaster of Paris workers, for hardening the same materials—in short, as a substitute for all kinds of gelatines, over which it has the advantage of producing a firmer jelly. Another seaweed much used for industrial purposes is the *fu*, resembling carrageen, or Irish moss, and applied to similar uses, such, for instance, as the sizing of the warp of silk goods. Recently the manufacture of an isinglass of this kind has sprung up in France, being made from the seaweeds found on the coast of that country. In its crude state it is a yellowish gelatine, but after repeated experiments under the auspices of the Industrial Society of Rouen, it has been successfully converted into what bids fair to prove the best sizing for cotton cloth known, and will probably entirely supersede the Asiatic product. Macerated in water for 12 hours, boiled for 15 minutes, and stirred till it becomes cold, the article gives a clear solution, which, as it does not again become a jelly, can be laid in its cold state upon any textile fabric and be left to dry. One invaluable property it possesses is that of defying at common temperatures damp and mildew; and it is therefore being applied to give a lustre not only to French prints and muslins, but also to woollens and silks. In China, the first quality of the seaweed isinglass is used in a number of industries, especially in stiffening light and transparent gauzes, and the fine silk which is used for making fans, screens, hangings, &c. It is on these stuffs, so well stiffened, that the artists produce such beautiful designs in colours, incomparable for their freshness and brilliancy. A second quality of the article, of darker tint, is used by the makers of paper umbrellas, parasols, and lanterns, to smear the fine stretchers of bamboo on which they are formed. When thoroughly dried, these articles of such extensive use acquire an impermeability of long duration. (*Scient. Amer.*)

The seaweed *Arachnoidiscus japonicus*, which is used by the Japanese and Chinese to pack porcelain and other articles for exportation, is said to be made use of in France for the purpose of making artificial fruit jellies.

Consul Quin gives the following description of the method in which Japanese cut seaweed is prepared for the market:—For making the finest cut seaweed, the best long seaweed is used, the newer the better, on account of the colour. After the bundles are opened, they are picked, and as much sand as possible is shaken out; the selected weed is then placed in large boilers, and is boiled for an hour or more, until the proper colour is obtained, which should be quite uniform and of a good clear green. After boiling, the seaweed is hung up on poles in the air to partially dry it, after which it is again carefully sorted, and all ragged pieces and those of a pale whitish colour are rejected; the selected weed is then handed over to a number of women, who open it out and roll it into flat coils of about 10 lb. each. As soon as these coils have remained long enough to flatten the seaweed, they are uncoiled, and the pieces of weed are laid out one on the top of the other, on a board a little over 4 ft. long, to the depth of 8 to 10 in.; they are then cut into 4 lengths of 13 in. each, and these pieces are tied into bundles ready for the workmen to lay in the presses, which are about 6 ft. wide, 13 in. deep (the length of the pieces of seaweed), and 6 ft. high. At the bottom, a row of wooden slats, about 2½ in. broad, ½ in. thick and 13 in. long, are placed edgeways, and upon these the weed is laid carefully piece by piece in the frame, the sides of which are kept in position by a rope stretching across the top; a movable plank at the back, which is raised as the workman proceeds, keeps the weed thoroughly even. When the frame is full—about 2 tons going into one press—a similar lot of slats to those at the bottom are placed on the top of the seaweed, and the whole is pressed as tightly as possible by means of a rough capstan, to get rid of all unnecessary moisture, and to render the mass firm enough for cutting. The frame is then laid down flat; and one of the side planks being removed, the compressed weed is planed with an ordinary carpenter's plane, so as to cut it to the required thickness—about $\frac{1}{20}$ in.—along the edges and with the grain. The object of the slats is to enable the workman to plane to the edges, and they are removed one by one as he progresses with his work. Each man can plane on an average 170 lb. of seaweed per day. After planing, the cut seaweed is taken out of doors and shaken out to dry on mats; under favourable circumstances, one day is sufficient for this operation, but it frequently happens that as many as 3 days are required before it is dry enough to pack away. After the final drying, the weed is ready for the market, and is packed away in boxes containing about 66 lb. each. The rejected ends of the first-class seaweed are used up together with ordinary long seaweed of an inferior quality, to make cut seaweed of a lower class. While undergoing the various processes, the material loses 20 per cent. in weight, and that fact, joined to the price of the labour expended in its manufacture, brings the cost to more than double the average of long seaweed. (*Soc. Arts Jl.*)

Thao is a very interesting substance, and one which is likely to come into considerable demand in the future. It is a gelatinous preparation made in Cochin China, as well as in other eastern countries, from seaweed. In the English market, it has frequently appeared, under the name of Chinese or Japanese isinglass, in three different forms. That which is prepared in Cochin China is in bundles of thread-like pieces a foot or more long, about the thickness of whipcord. The specimens prepared in Japan occur in two forms, one in square sticks about 11 in. long and 1 to 1½ in. in diameter, and full of cavities, each weighing only about 3 dr.; and the other in bundles of long shrivelled pipe-like pieces about ⅛ to ¼ in. in diameter and about 14 in. long. The bundles are fastened at the ends with the stems of some grass. When immersed in water, these pieces are seen to have the same square shape as the other varieties. One side of the pieces is always more full of diatoms and other foreign bodies, as if the pieces had been formed in a mould in which the sediments of the jelly had gone to the bottom. The cord-like variety made in Cochin China is in long loose bundles. It has much the polished appearance of the Chinese vermicelli made from rice, but that substance will not bend and is much more slender. Various trials have been made with it in France since 1874, especially by D. Gantillon and Co. at Lyons, and the Industrial Society at Rouen. The *thao* is prepared for use in the following way:—After having been soaked in cold water for about 12 hours, it is boiled for ¼ hour, during which it absorbs about 100 times its weight of water. If allowed to cool, it becomes a jelly; but if passed through a sieve and stirred until cold, it remains fluid, and in this state is more easily employed than when hot. The yellowish matter which some specimens contain can be removed by boiling for some time, when it forms an insoluble scum, which appears to consist of very thin fibres, and which remain attached to the sides of the vessel. A singular property, and one which perhaps might be turned to valuable account, is, that *thao* jelly does not decompose solution of permanganate of potash, even when left in contact with it for 24 hours. According to Heilmann, of Rouen, *thao* produces, in the proportion of ·1 part to 100 of water, a dressing which is supple and strong, and which gives substance rather than stiffness to calico; while dextrine, like starch, make the tissue drier and harder, and gives less facing to the thread. The addition of glycerine gives a dressing still more flexible and soft, and while rendering the tissues less stiff it communicates more body to them. The addition of talc gives still greater smoothness. Once dissolved, according to Gantillon, *thao* will mix while hot with any gum, starch, dextrine, or gelatine. The principal advantages of *thao* in dressing silk fabrics is, that while preserving their suppleness it gives them greater glossiness and makes them soft to the touch. The mixture of *thao* with gum tragacanth is said to be the best method of using it. *Thao* should, however, be used alone for materials which it is not necessary should be stiffened. As *thao* is only soluble at a high temperature, a moist atmosphere, fog, or even rain does not affect the material dressed with it. It combines well with sulphate of copper and the chlorides of aniline and potassium, and can be used in double dyeing. It also answers well for sizing paper, &c. The only obstacle to its extensive use is its high price. There is, however, no reason why a similar substance should not be made from our common native seaweeds, of which *Gelideum corneum* and *Gracilaria confervoides* approach most nearly in character the algæ from which *thao* is made. Gelose, of which *thao* consists, differs from the carrageenin obtained from *Chondrus crispus* in its power of combining with a very large quantity of water to form a jelly; it yields 10 times as much jelly as an equal weight of isinglass. For purposes of food, *thao* jelly is not quite so pleasant as animal jelly, as it does not melt in the mouth; it also contains no nitrogen. A great advantage which it possesses is, that it is but little prone to undergo change—so much so that the jelly is sometimes imported from Singapore, sweetened, flavoured, and ready for use, and may in this state be kept for years without deterioration. The west coast of Australia also yields a seaweed possessing similar properties. *Porphyra vulgaris* (the "laver" of English coasts) is given as the source of the seaweed isinglass in square sticks. In Cochin China, this variety appears to be known under the name of *mut*. A number of other seaweeds are, however, collected, and are known to the Annamites under the general name of *rau-cau*, while in Chinese medicine they are called *hai-thao*. These algæ are gathered in considerable quantities in the islands of Cu-lao-Khaoi and Cu-lao-ré, those collected in the latter being considered of the best quality. (*Pharm. Jl.*)

IVORY SUBSTITUTES.—Of late years, the scarcity and dearness of genuine ivory have driven inventors to manufacture artificial compounds capable of replacing it for many industrial and domestic purposes. These compounds, which may almost without exception be included under the name "celluloid" (called also parkesine, xylonite, pyroxyline, artificial ivory), will here be described.

In general terms, celluloid is formed of divided cotton waste, or similar substance, dissolved in one or more of the following solvents:—Vegetable naphtha, nitro-benzol, camphor, alcohol, and glacial acetic acid. Sufficient of these solvents is used to make a soft, plastic mass, which is then or subsequently subjected to hydraulic pressure, and mixed with oils, gums, and colours. By this means, any degree of hardness or flexibility can be given to it, and it can be made white and transparent or of brilliant colour. It can be made as hard as ivory, or retained in so soft a condition as to be spread in layers over textile fabrics much in the same way that paint is laid on. The substance is water-proof, acid-proof and air-proof. It can be worked in a soluble, plastic, or solid state. It can be pressed and stamped, planed as wood, turned in a lathe, cut with a saw, carved, inlaid, woven into fabrics, and, as already has been stated, applied as a varnish. It can be made either transparent or opaque, and is capable of bearing a high polish. When dyed, the dye runs through the whole substance, and cannot, consequently, be rubbed or washed off.

The manufacture may be divided into two distinct stages:—1. The production of the so-called "pyroxyline;" 2. The treatment of this compound with solvents, in order to make it plastic, and give it other desired qualities. The first stage of the process suffers but little variation. A convenient quantity of cellulose or woody fibre, such as disintegrated cotton waste, paper, &c., is fed into an open vessel called a "converter," and treated with an acid mixture composed of 1 part of nitric acid, sp. gr. 1·420, and 4 to 5 parts of sulphuric acid, sp. gr. 1·845, mixed in a separate vessel, and kept as cool as possible. The acid mixture is pumped or forced up into the converter, while the fibrous substance, previously placed in a hopper over the converter, falls gradually into it by an opening in the top. *The charging of the cotton* into the converter occupies about 10 minutes, and at the end of 20 to 30 minutes at most, it is chemically converted into the so-called pyroxyline or nitro-cellulose. This, together with the excess of acids adhering, is then allowed to fall through an opening in the bottom of the converter, and is caught in a large box provided with a false bottom of perforated iron or wire gauze, at about 6 in. above the real bottom. On this the wet mass remains for an hour, to admit of the excess of acids draining away as far as possible; the still remaining impregnations of acid are then expressed by placing the pyroxyline in a cylinder with a perforated bottom, and subjecting it to hydraulic pressure. The result is a hard cylinder of pyroxyline, containing about 5 to 20 per cent. of the acid mixture, in which state it is stored for future use. When required, the cylinders of pyroxyline are torn into dust by special machinery, such as that employed for grinding paper pulp, and the disintegrated mass falls into a large tank, where it is well washed with water, to remove the last traces of acid. It is then again placed in the cylinders with perforated bottoms, and pressed to remove the water, leaving in only 5 to 20 per cent. The solid cylinders of soluble pyroxyline are again broken up in the disintegrating machine, preparatory for the treatment with solvents, which forms the second stage of the manufacture.

This is performed in a variety of ways, chiefly according to the ulterior applications for which the product is intended, and differing less in the apparatus employed than in the ingredients and proportions of the dissolving agents.

(1) One of the first solvents employed on a large scale was wood naphtha, distilled with chloride of lime, in the proportion of 1 gal. of the naphtha to 2 to 6 lb. of fused chloride; the more of the latter used within these limits, the stronger will the solvent be. The first 3 qt. of the distillate are collected for use; the remainder is caught in a separate vessel so long as any spirit comes over, and is distilled again at the next operation with more fresh materials. The deposit remaining behind in the still is chloride of lime, dissolved in water and contaminated with some tarry matter. It is run into an open iron vessel, heated by a fire beneath, to evaporate away the water and fuse the chloride of lime ready for re-use.

(2) The solvent thus prepared is applied to the pyroxyline in such proportions as to make a pasty mass; but if used alone, the resulting celluloid would soon become hard and brittle. To avoid this, a certain quantity of oil is added to the mass, and kneaded up with it in the mixing machine. The proportion of oil will vary with the desired degree of toughness. To produce a consistency

suitable for coating telegraph wires, or for spreading on textile fabrics, the proportion of oil may equal half the weight of the pyroxyline. If the oil used be first treated with chloride of sulphur, the compound is much more elastic. It is thus treated by mixing with 2 to 10 per cent. of liquid chloride of sulphur, according to the degree of elasticity required; but the chloride of sulphur should first be diluted with an equal bulk or more of mineral naphtha, or bisulphide of carbon, to prevent too violent action. The prepared oil is compounded with the dissolved pyroxyline in various proportions, but seldom exceeds 20 per cent.

(3) To increase the hardness and modify the colour of the product, sometimes a small portion of gum or resin, such as shellac or copal, is added, but seldom more than 5 per cent. The wood naphtha may be replaced by alcohol, and the chloride of lime by chloride of zinc, or manganese fused or dry. For economy sake, a small quantity of light spirits from coal may be mixed with the solvent, but it is not preferable. For the oil may be substituted balata gum treated with chloride of sulphur — usually not more than 5 per cent. of the chloride. The combustibility of celluloid thus made may be corrected by the addition of chloride of zinc or tungstate of soda. Ten per cent. of either effectually prevents burning; but usually much less will do, especially when pigments are used. The same end is attained by employing iodide of cadmium, oxalate of zinc or manganese, or gelatine dissolved in glacial acetic acid.

(4) A practical difficulty attending the use of the above process is that the solvents employed are so volatile. Large masses of celluloid may be prepared better, quicker, and with less consumption of solvent by adopting nitro-benzol, aniline, or glacial acetic acid, and the celluloid may then be worked in the open air. The ordinary volatile solvents are improved by the addition of camphor.

(5) When using nitro-benzol, the commercial article should be distilled off hydrochloric acid or chloride of lime, say 6 lb. of either to 1 gal. of nitrobenzol, which is thus rendered purer and sweeter. One hundred parts of pyroxyline are then moistened with ordinary solvent — preferably naphtha distilled off chloride of lime—and the excess of solvent is removed by hydraulic pressure. The other solvent is then added in the proportion of 10 to 50 parts of prepared nitro-benzol or aniline, together with 10 to 50 parts of camphor, and 150 to 200 parts of oil, preferably cotton-seed or castor. This mixture is forced between rolls, heated by steam being admitted into them, till the whole forms a well-combined dough or paste, which will be more or less stiff according to the quantity of solvent used. For a hard compound, the oil should be less than the pyroxyline; for a soft one, it should exceed the latter—say, 150 to 200 oil to 100 pyroxyline. In making celluloid with glacial acetic acid, 100 parts of pyroxyline are dissolved in 50 parts of the acid, for a stiff paste; or 100 to 300 or more parts, for a semi-fluid consistency.

(6) Usually the pyroxyline requires to be dried before dissolving it. The conduct of this operation on large quantities requires much care and time, and a very large space of drying room, so that great advantages, on the score of cost, ease, and safety, are to be derived from dissolving it in a moist state. For this purpose, the pyroxyline is prepared in the usual way, and when rendered soluble by the addition of hydrocarbon solvents, it is taken out of the acids and placed in a hydraulic machine, by which as much as possible of the acid is expressed. The cake of pyroxyline is then taken out of the press, opened out, put into a centrifugal washing machine, and washed with water until clean; then the rotation of the machine is continued, to throw out the surplus water. Or the pyroxyline, after conversion, may be placed in the centrifugal machine, and there deprived of the acids, and, without removal, be thoroughly washed by admitting a copious supply of water, the operation occupying from a few minutes to an hour. When the pyroxyline does

not contain more than 5 to 10 per cent. of water, it is dry enough for solution in naphtha, &c.

(7) Instead of evaporating the solvent used in making the celluloid, it may be removed by precipitating the pyroxyline by means of water, mineral naphtha, &c. There is thus obtained a semi-solid mass, containing a small quantity of the solvent, which is passed through grinding rolls or other disintegrating machinery, and then worked up as usual. The celluloid is placed in a vessel containing a revolving agitator or beater, together with water or mineral naphtha in the proportion of 1 lb. of celluloid to 1 qt. of liquid, and the agitator is set in motion. After a short time, the celluloid is let out in a curd-like form, and submitted to pressure (not excessive), to separate the liquid. It is convenient to place it in a vessel of cylindrical form, and about 12 in. in diameter, provided with a movable and perforated bottom, covered with several layers of wire gauze. This is filled with the curd-like celluloid, upon which a plunger is forced down, and a cheese-like block is produced. This is rolled down between rollers heated by steam, and any pigment, &c., is worked in by them at the same time, the mixture being passed through and through till perfected. The solvent used is preferably mineral naphtha, as free from smell as possible. The solvent taken up by the liquid is recovered by distillation, if water has been used; but in the case of naphtha, the greater part will separate on standing, and may then be decanted off.

(8) In order to make celluloid in imitation of pearl, fish-scales are mixed with the dissolved pyroxyline, and a pearly-lustrous material is thus produced. To form a thin veneer of artificial pearl, 1 part of this material is mixed with 100 parts of pyroxyline. The latter is first ground with a solvent and oil to a doughy consistency, the pearly compound is then added, the solvent is separated, and the celluloid is worked up in the ordinary way. But when the celluloid is required in a semi-fluid condition, the solvent must be increased instead of removed, and a much larger proportion of the pearly material will be needed. The best lustre produced is that made in France from the scales of the whiting. In producing a coloured celluloid, preference should always be given to dyes—especially aniline—rather than pigments. The brightest and most delicate colours may be imparted.

(9) To manufacture celluloid so as to resemble ivory, the following plan is adopted:—The celluloid is made without any colouring matter, and is kept as clean and white as possible; when in a doughlike state, it is rolled into sheets $\frac{1}{16}$ in. thick. Meantime another celluloid is prepared containing carbonate of strontia in the proportion of 1 part to about 200 parts of pyroxyline, and this also is rolled into sheets. These sheets are placed alternately one over another, to produce any desired grain. A good plan is to lay a transparent and an opaque sheet one over the other, and roll them up together, then take the roll and twist it, pass it through heated rollers, and roll it down into a slab, for cutting knife handles or whatever may be required.

(10) In working white or light-coloured celluloids, or those in imitation of pearl or ivory, it is necessary that porcelain or glass vessels should be used in its manufacture as far as possible, and the rollers through which it is passed must be covered with platinum, as other metals are acted upon by the celluloid. A coating of platinum $\frac{1}{16}$ in. thick will be very durable.

(11) For producing a white celluloid, without unduly increasing its specific gravity, the dissolved pyroxyline and other ingredients are mixed with white starch, either from wheat, rice, potatoes, &c., or with arrowroot, tapioca, or other amylaceous substance, or with wheat flour, or with cotton ground and bleached.

(12) To remove the solvent remaining in the celluloid, which imparts a slight odour to articles made of it, and renders them liable to shrink in course of time, such articles are seasoned, while

in a partially manufactured state, by soaking them in a liquid which will dissolve out the solvent without affecting the pyroxyline, such as bisulphide of carbon, chloride of lime, or benzol. The articles so soaked are afterwards placed in a vessel from which the air is exhausted, and the curing liquid is thus drawn out, condensed, and recovered.

(13) The process employed for making billiard balls is as follows:—To 100 parts of pyroxyline, dissolved, ground, and strained as usual, are added 300 to 500 parts of the usual solvent—alcohol 100 parts, naphtha 50 parts; 100 to 150 parts of arrowroot or starch; 50 to 100 parts of the best zinc-white. The solid matters are added to the plastic solution of the pyroxyline, and the whole is placed in a closed rolling or grinding apparatus, the rollers being heated by steam, and the compound is ground up till most of the solvent is driven off. The latter is recovered by conveying it through pipes to a Liebig's condenser. The mass is now about as stiff as clay, and may be moulded or rolled, and placed in a warm place for seasoning. When well seasoned, the ball may be turned. When less specific gravity is required, it is best to employ as much amylaceous substances as possible, they being lighter than the zinc. Ground and bleached cotton fibre may be rubbed up with the plastic pyroxyline, in the proportion of 100 parts disintegrated cotton to 300 parts pyroxyline paste. When making coloured celluloid with amylaceous substances or cotton, the colours should be added at the same time, and ground up with the other ingredients.

(14) A modification worth mentioning consists in employing camphor as the solvent of the pyroxyline. The latter is first reduced to a fine pulp by grinding it in water in a machine such as is used for grinding paper pulp, and to the pulp thus prepared pulverized camphor is added in the proportion of 1 part by weight of camphor to 2 parts pyroxyline when dry. At the same time is added any desired material for colouring the celluloid or modifying its specific gravity. The camphor is comminuted by grinding in water, trituration, or solution and precipitation. The camphorated mass is placed in a mould, and heated to a sufficient temperature to liquefy or vaporize the solvent, and is then subjected to heavy pressure. The temperature should never exceed 300° F. (149° C.), or the pulp in contact with the mould will become charred; sometimes 150° F. (66° C.) suffices. The mixture should remain in the mould under heat and pressure till the conversion of the pyroxyline is completed; it is then left to cool under pressure in the mould. When first taken out, it has the consistency of sole leather; but is easily softened by heat till the camphor has evaporated, when it grows as hard as horn.

(15) For dental purposes, the transformation of the pyroxyline is effected by camphor, and without the use of fixed oils or fusible non-solvent gums, which are required to be combined with the material when ether, alcohol, &c., are used, and which would impair the strength, durability, purity, and firmness of texture essential in dental plates. 50 parts at least by weight of camphor are added to 100 parts of soluble pyroxyline; more camphor makes the compound more plastic. The plates formed are placed in a drying-room heated to 150° to 180° F. (65° to 82° C.), the latter being the maximum, to drive off the camphor. A temperature above 200° F. (93° C.) will expand the material, and make it porous and brittle. It is said that this compound is lighter and stronger than dental vulcanite or indiarubber; its colour is the same as the natural gum, and is unchangeable; it has no unpleasant taste; it is absolutely non-injurious, and never shrinks or warps after setting.

(16) The following process is adopted in practice to dissolve the pyroxyline in camphor, eliminate the solvent, and form a solid mass of celluloid at one operation. The prepared mixture of soluble pyroxyline and camphor is first

dried, by compressing the moist pulpy compound into convenient sized cakes, about $\frac{1}{4}$ in. to $\frac{1}{2}$ in. thick, and arranging them in a pile with intermediate layers of paper, or other absorbent material, and subjecting the pile to pressure in a hydraulic press. By this means, the material is uniformly and sufficiently deprived of its moisture, while the compression of the material and exclusion of the air prevent all danger of ignition when exposed to the sun or the heated air of a drying-room. The mixture of pyroxyline and camphor is subjected to pressure by means of a plunger in a heated cylinder provided with a discharge nozzle or pipe, the cylinder being of sufficient length to cause the conversion of the pyroxyline to take place while the material is being gradually forced through it, so that by replenishing it as it becomes partially empty, a gradual discharge of the celluloid is effected, in the form of a continuous bar or sheet. The cylinder is unequally heated, in such a manner that the mixed material will first be compacted in the colder portion, before the solvent is melted and the process of transformation commences. The air is thus allowed to escape more freely, and is more completely expelled, while the conversion of the pyroxyline is effected in another and hotter portion of the cylinder, as the mass is forced through it. The upper or receiving end of the cylinder is cooled by being surrounded by a cold-water jacket; and the lower or discharging end is heated by a steam or hot-water jacket. The former is supplied by the escape pipe of the hydraulic engine. In the discharge end of the converting cylinder is a central heating and distributing case, constructed with radial pins or projections, by which the material, before it escapes from the cylinder, is caused to pass through the annular space around the central core, and in contact with the heated surface of the cylinder, while the spurs or pins divide and mix the material, and at the same time serve to conduct the heat from the cylinder to the central core. The discharge pipe is passed through an equalizing warm-water vessel, which keeps it sufficiently warm to prevent the material in contact with the inner surface cooling faster than the central portion, as the unequal cooling, and consequent unequal consistency, of the different portions of the material would cause the central and softer portion to move faster than the outer and harder portion, thus destroying the homogeneity of the mass, and rendering the surface rough and broken. The soluble pyroxyline is first comminuted in a wet condition, and the excess of water is pressed out. The camphor and colours, as required, are then thoroughly incorporated with it by the mixing rollers. The compound, thus prepared, is formed into cakes by means of a mould and follower, the bottom of the mould being made separate, and serving to transfer the formed cake to the pile. These cakes are preferably made about 12 in. square, and $\frac{1}{4}$ to $\frac{1}{2}$ in. thick; it would be difficult to properly absorb the moisture from thicker cakes. These are laid up in a pile with layers of blotting-paper between them, and are then placed in a hydraulic press to remove the water as far as necessary. During this process, the compound is protected from the air, to prevent evaporation of the camphor and to avoid the chance of ignition. The rapidity with which this drying is effected ensures great saving of time and space. The dried material is ready for conversion into celluloid, for which purpose it is transferred, with the solvent, to the converting cylinder. The heat from the steam-jacket surrounding the lower portion of this cylinder brings about the conversion of the pyroxyline to a homogeneous mass of celluloid, which is then forced through a discharge nozzle, constructed according to the desired form of the product, *e.g.* in bars or sheets, or directly into a mould of the article to be manufactured.

(17) The use of various solvents and combinations of solvent materials has been attempted or proposed; *e.g.* a

mixture of camphor and oils in about the following proportions, viz. :—

Camphor, camphor oil, or liquid camphor	20 pts.	by wt.
Oil, such as castor or linseed, before or after boiling	40 ,,	,,
Pyroxyline (soluble)	40 ,,	,,

These will give a consistency suitable for covering telegraph wires, or for moulding or spreading. For material with greater or less flexibility, or greater or less fluidity, the proportion or character of the oil must be changed. In producing very hard or rigid material, it is preferable to use oils which will themselves harden by exposure to air, as those which have been boiled. Camphor may also be used in about equal proportions with hydrocarbons having a boiling point at 220° to 400° F. (104°–204° C.), or with alcohol or spirits of wine; or hydrocarbons in equal proportions with alcohol; or castor-oil in equal proportions with alcohol; or a distillate of a mixture of camphor-oil and hydrocarbons, or of camphor and bisulphide of carbon in conjunction with alcohol; or aldehyde, either alone or with alcohol. Either of these solvents may be employed with the other ingredients in about the following proportions, to produce a semi-fluid celluloid :—

Pyroxyline (soluble)	27 pts.	by wt.
Castor-oil	27 ,,	,,
Camphor	6 ,,	,,
Either of the foregoing solvents	40 ,,	,,

The consistency will depend chiefly on the proportions of the oil, as before.

(18) Parkes suggests the use of a solution of carbon tetrachloride and camphor, either alone or with gums, resins, oils, dyestuffs, &c. He also proposes to use carbon bichloride and camphor, when the solution takes place under the aid of heat and pressure. Camphor, too, is a good solvent when heated to its melting-point; at this temperature and under pressure, it dissolves the nitro-cellulose as fast as it can be mixed with the melted camphor, until it forms a stiff mass. This mass, to which other substances may be added, can be rolled and pressed into moulds. To lower the melting-point, he adds oil, paraffin, turpentine, alcohol, benzol, ether, &c., whereby thinner solutions are obtained. Another powerful solvent for nitro-cellulose can be made by conducting sulphurous acid gas through granulated camphor, or by dissolving camphor in sulphurous acid. A solution of camphor in benzol, of such quality that no unpleasant odour is left when the compound is done, works very rapidly with the aid of heat and pressure. Oils, gums, resins, and dyes can be added according to taste. Turpentine and camphor also dissolve it with heat and pressure very quickly. Nitro-cellulose softens rapidly if sprinkled with alcohol, ether, or other solvents of gun cotton, and then pressed into hot moulds.

(19) The pyroxyline is obtained from cigarette paper of very good quality. This paper, in rolls 13 in. in width and 33 to 35 lb. in weight, is unrolled mechanically and immersed in a mixture of 5 parts of sulphuric acid of 66° B., with 2 parts of nitric acid of 42° B., kept at a temperature of about 95° F. (35° C.). The cellulose of the paper, after 12 or 15 minutes' immersion, becomes changed into nitro-cellulose, which is soluble in a mixture of alcohol and ether. The solubility is tested by a hasty trial. The product is then removed from the acid bath, the liquid is expressed from it, and it is thrown into water. After a preliminary washing, it is placed along with water in a pulp vat, and triturated for 2½ to 3 hours in order to obtain a homogeneous paste. The pyroxyline then has to undergo bleaching, the operation being effected by the use of a solution of potash permanganate. When contact with this reagent has been sufficiently prolonged, the excess of permanganate is eliminated by washing. Then the mass is treated with a solution of sulphurous acid in order to dissolve the oxide of manganese, and the operation is finished by a series of washings in water. The whitened pyroxyline is put into boxes lined with filtering cloths, and then submitted to mechanical drying. On being taken from the hydro-extractor,

the material still retains about 40 per cent. of water, and is found to be in a state fit for the preparation of celluloid. It is then passed through a mill having metallic runners, first alone, and afterwards mixed with the proper quantity of camphor (which has been first rolled), and with colouring matters if it be proposed to make opaque celluloid. After a dozen successive grindings, the mixture is moulded in a metal frame, by hydraulic pressure, so as to give slabs, that are arranged and pressed between 10 to 12 sheets of thick bibulous paper. The water in the mixture is then gradually absorbed by the paper, the latter being renewed 12 to 15 times. The slabs, thus dried and reduced to a thickness of about $\frac{1}{10}$ in., are broken up between bronze cylinders armed with teeth. The pieces are allowed to macerate for about 12 hours with 25 to 35 per cent. of alcohol of 96°, and then the colouring matters soluble in alcohol are added, if it be proposed to have transparent coloured celluloid. The mixture is then passed through the rolling-mill, the cylinders of which are heated to about 122° F. (50° C.). The operations are performed upon 20 to 28 lb. at once. The rolling takes 25 to 35 minutes, and terminates when the material has become homogeneous. There is then obtained a sheet of about ½ in. in thickness, which is cut into pieces of 23½ by 31½ in. The latter are superposed on the table of a hydraulic press in a metallic box having double sides and being tightly closed, and allowing the heating to be done by a circulation of hot water. The box is heated to 140° F. (60° C.) during the whole duration of compression, which lasts about 4 hours. At the end of the operation, a current of cold water is passed into the box, the pressure is removed, and there is obtained a very homogeneous block of celluloid about 5 in. thick. The blocks are taken to the planing machine, and shaved into sheets varying from 0·008 to 0·12 in. in thickness, according to the purpose for which the product is designed. These sheets are next placed in a ventilated stove, heated to 131° F. (55° C.), where they remain for 8 days to 3 months, according to their nature and thickness.

In this description it has been only a question of celluloid of a uniform colour, either transparent or opaque, imitating pale tortoise-shell, coral, ebony, turquoise, &c. When it is desired to obtain a product to imitate amber, jade, spotted tortoise-shell, &c., each of the ingredients, of uniform colour, which is to compose the material, is prepared separately, and then mixed, to be afterwards united by pressure.

(20) A new compound, said to be fireproof, and suitable as a substitute for ivory, is thus made:—A solution is prepared of 200 parts of casein in 50 parts of ammonia and 400 of water, or 150 parts of albumen in 400 of water. To the solution the following are added: quicklime, 240 parts; acetate of alumina, 150 parts; alum, 50 parts; sulphate of lime, 1200 parts; oil, 100 parts. The oil is to be mixed in the last. When dark objects are to be made, 75 to 100 parts of tannin are substituted for the acetate of alumina. When the mixture has been well kneaded together and made into a smooth paste, it is passed through rollers to form plates of the desired shape. These are dried and pressed into metallic moulds previously heated, or they may be reduced to a very fine powder, which is introduced into heated moulds and submitted to strong pressure. The objects are afterwards dipped into the following bath:—Water, 100 parts; white glue, 1 part; phosphoric acid, 10 parts. Finally, they are dried, polished, and varnished with shellac.

(21) Any form of cellulose is the basis. Sulphuric acid, sp. gr. 1·84 to to 1·85 (75 parts), is placed in a receiver, with 25 parts commercial nitrous acid; a saturated solution of peroxide of nitrogen in nitric acid, sp. gr. 1·420, is retorted a little below 132° F. (55½° C.), the fumes passing into the sulphuric acid until it is saturated by them. The cellulose is immersed in this acid, 11 lb. of cellulose to the gallon, then taken out and left to stand an hour, then thoroughly washed and

dissolved in alcohol (sp. gr. 0·920) 75 parts, and coal-oil 25 parts, in the proportion of 11 lb. solvent to 11 lb. fibre.

(22) In making articles of artificial ivory, the greatest difficulty hitherto has been that, in order to gain the necessary firmness, a large percentage of the binding substance had to be used, and hence only dull-coloured articles could be produced. Recently J. S. Hyatt has produced a substance in which only very little gum or other cementing material is used, so that, without detriment to its durability, the finished article may still have a pure white colour. This result is arrived at by grinding up any suitable inert matter with a solution of a proper cement. The cement solution is then expressed, the residue is dried and ground, and the powder thus obtained is heated and pressed into moulds. The most suitable inert matter found is oxide of zinc, and the best cement is shellac, or some other similar vegetable substance. A solution of NH_3 forms the solvent. Hyatt first dissolves 8 parts shellac in 32 parts NH_3, sp. gr. 0·995, by thoroughly mixing the two at a temperature of 99° F. (37½° C.) for 5 hours in a rotating cylinder. 40 parts of oxide of zinc are now mixed by hand into the thin syrupy solution, and the mixture is well ground in a colour-mill. The NH_3, having served its purpose, is now driven off by heat, or by exposing the mixture on glass plates for a long time to the air. The residue, consisting merely of dry shellac and zinc oxide, is again finely powdered, and the powder thus obtained is pressed into the moulds with a pressure of about 2000 lb. per sq. in., and at a temperature of 257° to 280° F. (125° to 137½° C.). If the article is to be coloured, the colour is added either to the solution just before the first grinding, or to the dry mass before the second grinding.

LEATHER.—Within the limits of the present volume it would be impracticable to give a complete treatise on the manufacture of leather; but there are many recipes and processes involved in it which may fitly occupy a place here. Those desirous of consulting a more elaborate essay will find it in Spons' 'Encyclopædia,' pp. 1213–1240, from which most of the following information has been condensed.

Calf-kid. — Calf-kid is used for light upper leathers, and is "tawed" instead of tanned. In this respect, and in most details of its manufacture, it resembles glove-kid.

This process is as follows:—Selected calf-skins, dried or salted, are the raw material, and after a suitable softening in fresh water, are limed for 2 to 3 weeks, or till the hair goes easily. They are then unhaired and fleshed in the usual manner, pured with a bate of dogs' dung, scudded, and again cleansed with a bran drench. In Germany, the bran drench is used alone, and is composed of 33 lb. bran to 100 medium skins. Before use, the bran should, especially in summer, be well washed to free it from adhering meal. The temperature of the drench should not exceed 100° F. (38° C.), and the skins should remain in for 8 to 10 hours. Lactic acid is produced by fermentation; this removes lime, and is itself neutralized by the products of putrid fermentation which succeeds it.

The tanning is accomplished in a drum with a mixture of alum and salt; and after drying, the skins are again moistened, and worked in the drum with a mixture of oil, flour, and egg-yolk. In the German method, these two operations are combined. Eitner, who has written a series of articles on the process, gives 40 lb. flour, 20 lb. alum, 9 lb. salt, 250 eggs or about 1¼ gal. of egg-yolk, ⅞ pint of olive-oil, and 12 to 16 gal. water, as a suitable mixture. The skins are worked in a drum-tumbler (preferably a square one) for 20 minutes, then allowed to rest 10 minutes, and this process is twice repeated. The temperature must not exceed 100° F. (38° C.), and it is said to be important that the drum should be ventilated by holes at the axis.

The skins are allowed to drain, and then rapidly dried at a temperature of 140° to 160° F. (60° to 71° C.), and after "samming," or damping with cold water, are staked by drawing them to and fro over a blunt knife fixed on the top of a post. They are then wetted down and shaved, with either the moon-knife or ordinary curriers' shaving-knife, and sometimes receive a second dressing of oil, flour, and egg, to soften them still further.

Chamois-leather.—The process of manufacturing "chamois" or "shammy" leather is thus described by Dr. Ballard:—After the "pelts" have been fleshed and split, the inner or flesh sides are taken for the manufacture. This portion is again passed through the splitting-machine in order to take off from the thicker parts so much as may suffice to render the skin of uniform thickness throughout. It is again limed, then washed, and afterwards put into a bran drench. After removal from the drench, the skins are pressed nearly dry, and then removed in bulk to the stocks, where they are beaten until they are soft with heavy tilt-hammers. When soft, oil (cod-liver oil in preference) is sprinkled on them, and the "stocking" is continued, oil being added from time to time. The skins are then taken out and "aired-off," *i.e.* hung up in the room to dry. At works where there is a sufficient open space adjoining, the skins are in dry weather hung out in the open air. This "stocking" and "airing-off" are twice repeated, and the skins are then hung up in a chamber heated to about 120° F. (49° C.) by hot-air or steam pipes. An offensive vapour of acrolein becomes thus diffused in the chamber. When the skins are dry, they are "stocked" with oil again, and the beating is continued until the mass of skins becomes hot. They are then taken out, packed into a cask, covered over with blankets, and left to "ferment." The contents of the cask become very hot, and an abundance of vapour of acrolein is given off. After the fermentation has continued for a time, the skins are turned over and transferred to another cask. During this process, acrolein vapour is largely evolved, and affects very greatly the eyes of the workmen. The fermentation is continued until heat ceases to be generated, and then the skins are allowed to get cold. The next thing is to get the oil out. With this object, the skins are thrown into hot water, and thence transferred to a powerful press. After leaving the press, they are put into a "tumbler," or revolving barrel, with warm water and soda-ash, and subsequently washed with cold water. Lastly, they are passed between rollers to press out all remnants of moisture and soapy matters, and hung up in a loft to dry. The further processes consist of various manipulations of scraping, pulling, stretching, &c., for the preparation of a saleable article. The oil pressed out of the fermented skins is known as "sod oil." Before leaving the premises, it is customary to boil it in a pan heated by close steam, in order to drive off any water it may contain. It is then sent away for use by curriers.

Currying.—In general terms, the process of currying consists in softening, levelling, and stretching the hides and skins which are required for the upper-leathers of boots and other purposes demanding flexibility and softness, and in saturating or "stuffing" them with fatty matters, not only in order to soften them, but to make them watertight and to give them an attractive appearance.

It is obvious that great differences must be made in the currying process, according to the character of the skin and the purpose for which it is intended, since the preparation of French calf for a light boot, and of the heaviest leather for machine belting, equally lie within the domain of currying. The clearest idea of the general principles involved will be gained by taking a typical case, and afterwards pointing out the different modifications needed for other varieties. The French method of currying waxed calf is selected as an example, since the well-known excellence of this leather makes it interesting to compare the details with the methods ordinarily in use in this country.

After raising the skins from the pits and beating off the loose tan, they are hung in the sheds till partially dry, great care being taken that the drying is uniform over the whole skin. In modern shops, this drying is usually accomplished at once, and in a very satisfactory manner, by means of a hydraulic press. If dried in the air, they must be laid in pile for a short time to equalize the moisture, and then brushed over on flesh and grain. The next process consists in paring off loose flesh and inequalities. This is done on a beam, and with a knife similar to that used in bate-shaving. This knife has the edge turned by rubbing with a strong steel, and is called *couteau à revers.*

Next follows the *mise au vent.* The skins are first placed in a tub with water or weak tan-liquor for 24 hours; they are then folded and placed in a tub with enough water to cover them, and beaten with wooden pestles for ½ hour. At the present day, stocks, or a "drum tumbler," a machine on the principle of the barrel-churn, usually take the place of this hand labour. The skin is next placed on a marble table, flesh upwards, and with one flank hanging somewhat over the edge, and is worked with a "sleeker" or stretching iron. The first two strokes are given down and up the back, to make the skin adhere to the table, and it is then worked out regularly all round the side on the table, so as to stretch and level it. The flesh is then washed over with a grass-brush, the skin is turned, and the other flank is treated in the same way. It is lastly folded in four, and steeped again in water. The next process is the cleansing of the grain. The skin is spread again on the table as before, but grain upwards, and is worked over with a stone set in handles, and ground to a very obtuse edge. This scours out the bloom; after washing the grain with the grass-brush, it is followed by the sleeking-iron as on the flesh.

The next step is re-setting. For this, except in summer, the skins must be dried again, either by press or in the shed. This is another setting out with the sleeker, and, the skin being dried, it now retains the smoothness and extension which are thus given to it. The skins are now ready for oiling in the grain, for which whale-oil or cod-liver oil is generally employed. (Olive-oil, castor-oil, and even linseed-oil, may, however, be used, and are sometimes made into an emulsion with neutral soap and water.) After oiling the grain, the skins are folded, and allowed to lie for two or three days before oiling the flesh.

The oiling on the flesh is done with a mixture of *dégras* and tallow, in such proportions as not to run off during the drying. *Dégras* is the surplus oil from the chamois-leather manufacture, which in France is effected by daily stocking the skins with oil, and hanging in the air for oxidation. The *dégras* is obtained, not by washing the skins in an alkaline lye, as in the English and German method, but by simple pressing or wringing. This oil, altered by oxidation, is so valuable for currying purposes that skins are frequently worked simply for its production, being oiled and squeezed again and again till not a rag is left. It is generally mixed in commerce with more or less of ordinary fish-oil. Eitner recommends, where the *dégras* is of indifferent quality, a mixture of 65 parts *dégras*, 20 of neutral soap (*i.e.* soap without the usual excess of alkali), and 15 of soft tallow. After oiling the flesh, which is accomplished by extending the skin on the marble table with the sleeker, and applying grease with a sheep-skin pad, it is hung to dry at a temperature of 65° to 70° F. (18° to 21° C.). After drying, the surplus oil is removed by a fine sleeker from both flesh and grain, and the skins are ready for "whitening." This consists in taking a thin shaving off the flesh, and was originally accomplished by the shaving-knife on the currier's beam; some curriers are still in favour of this method. It is now, however, done by a sleeker with a turned edge. The grain then undergoes a final stoning and sleeking, to remove the last traces of adhering oil, and the skin is grained by rubbing it in a peculiar way under a pommel covered with cork. It is then coated on the flesh with a mixture, of which the following is a specimen:—5 parts of lampblack are rubbed with 4 of linseed-oil, and 35 fish-oil are added; 15 of tallow and 3 of wax are melted together and added to the mixture and after cooling, 3 of treacle. This compound is put on with a brush, and allowed to dry for some days. Finally, the skins are sized over with a glue-size, which is sometimes darkened by the addition of aniline black.

To Curry Russet Leather.—The hide to be curried is placed upon a table, and a warm iron is rubbed over the flesh side; it is then turned over, and the grain side is moistened with water and rubbed with a copper sleeker until it is nearly dry, after which the colouring matter, made of Brazil-wood and yellow berries, is applied to the grain, and it is once more rubbed with the sleeker; it is then spread out to dry, and the final finish is given by rubbing the grain with a glass sleeker. This produces a very fine grade of leather for riding bridles, russet reins, &c. Use a strong solution of soda, apply it to the freshly-cut edges, and when nearly dry, rub with a woollen rag until a good polish is produced. To finish the edges of russet reins, use salts of tartar and water. If discoloured, first remove the stain with a weak solution of oxalic acid.

Depilatories, or Unhairing.—The removal of hair from hides is most commonly effected in England by the agency of lime, or by sweating processes demanding no further description. But besides lime many other substances have been proposed or adopted as depilatories, and these will now be noticed.

(1) An unhairing process, largely coming into use on the Continent, depends on the action of alkaline sulphides, and particularly sulphide of sodium, upon the hair. While the methods already spoken of involve the softening or destruction of the hair-sheaths, either by lime or by putrefaction, the sulphides are peculiar in attacking the hair itself; when strong, they disintegrate it rapidly and completely into a sort of paste. From very early times, sulphide of arsenic mixed with lime has been used in unhairing skins. About 1840 Böttger concluded that the efficacy of arsenic sulphide was due simply to the sulphydrate of lime formed by combination of the sulphur with the lime, and proposed sulphydrate of lime, formed by passing sulphuretted hydrogen into milk of lime, as a substitute for the poisonous and expensive arsenic compound. This proved a most effective depilatory, but has never obtained much hold in practice. This is probably due to the fact that it will not keep, oxidizing rapidly on exposure to the air; hence it must be prepared as it is required, which is both troublesome and expensive. A minor objection is the unpleasant smell of sulphuretted hydrogen, which is inseparable from its use.

(2) It was proposed to replace it by sulphide of sodium, which, though at first said to be only effective when mixed with lime, so as to produce calcic sulphide, has since proved a powerful depilatory alone. Its use has been greatly extended on the one hand by its production on a large scale, and in the crystallized form (presumably by reduction of sulphate by heating with small coal), and on the other, by the great interest which Wilhelm Eitner, the able director of the Austrian Imperial Research Station for the Leather Trades, has taken in its introduction. The substance, as manufactured by De Haen, of List, Hanover, is in small crystals, coloured deep greenish-black by sulphide of iron, which must have been held in suspension at the time of crystallization. If the salt be dissolved in water, and the solution be allowed to stand, this is gradually deposited as a black sediment, leaving the supernatant liquor perfectly clear and colourless.

For sole-leather, the method recommended by Eitner is to dissolve 4 to 5 lb. sulphide per gal. of water, making the solution into a thin paste (of soupy consistence) with lime or pipeclay. This is spread liberally on the hair side of the hides, one man pouring down the middle of the hide from a pail, while another, with a mop or cane broom, rubs it into every part. The hide is then folded into a cushion, and in 15 to 20 hours will be ready for unhairing, the hair being reduced to a paste. In H. R. Procter's experience, the concentrated solution here prescribed will completely destroy all hair wetted with it in 2 to 3 hours, and if left on longer, will produce bluish patches, and render the grain very tender. The hides should be thrown into water before unhairing, to enable them to plump, and to wash off the sulphide, which is very caustic, attacking the skin and nails of the workmen. There is no doubt that this process gives good weight, and tough and solid leather; but there are several difficulties attending its use. Unless the mopping is done with great care, it will fail to completely destroy the hair, and the patches of short hair left are very difficult to remove. The expense of the material and the loss of hair are also important considerations. The hides will be very difficult to flesh, unless previously plumped by a light liming, and it is generally considered necessary to swell the hides with acid before tanning, as the sulphide has but little plumping effect.

Another method, which is more generally adopted for dressing hides, is to suspend in a solution of sulphide of sodium containing about ¾ lb. a hide; the hide is said to unhair in 24 hours. Very weak solutions loosen the hair without destroying it; but it is always injured, as the specific action of the sulphides is on the hair itself. After unhairing, the hides may receive a light liming, to plump them, or lime may be added to the solution of sulphide.

Various other depilatories have been proposed, but as they have not come into general use, brief mention of the most important will suffice.

(3) Anderson, in 1871, patented the use of wood-charcoal, applied in a similar manner to lime in the ordinary process. The hair was probably loosened simply by putrefaction, as in sweating, while the charcoal acted as a deodorizer.

(4) Caustic potash and soda will loosen hair, but seem to have no decided advantage over lime. They are more costly, and their corroding action on the hide-substance is more powerful.

(5) Squire, Claus, and J. Palmer have all taken out patents for the use of tank-waste as a depilatory. It consists of impure sulphides of calcium, and when brought into the form of soluble sulphydrate, either by boiling in water, or, it is said, by the oxidizing of the air, it will unhair hides. The conversion is, however, very imperfect in either case, and its action is uncertain and slow; while the iron present is apt to cause unsightly stains. It is probable that the weights obtained may somewhat exceed those by liming.

(6) Palmer employs sulphuric acid to plump the hide and remove stains, and then reduces it by a bate of whiting and water. He claims that this prepares the hide for rapid and heavy tanning, but the swelling and subsequent reduction almost certainly entail loss of weight and quality.

(7) Instead of the offensive bate generally used, a composition holding 2 to 3½ oz. of realgar to 11 lb. of well-causticised potash is employed. It is applied, at a strength of 8° to 14° B., by means of a mop, to the flesh side of hides. It is also used in a vat for unhairing, at a strength of 1° to 4° B. For preserving hides for transport, he simply keeps the hides in a solution of American (caustic) potash, 8° to 15° B., with the addition of 30 gr. of salicylate of soda to every cwt. of composition, at 10° B. The hides are immersed, and then left wet, or dried. If dried, by steeping in water for 12 hours (the inventor states) they are brought back to their natural condition. (Moret.)

(8) *The Carter Process.*—Writers on tanning, theoretical and practical, all recognise the damage done to the hide by the use of lime, which, while decomposing the grain and roots of the hair, also injures the animal fibre. The caustic nature of the lime alters the texture of the skin more or less; and

as it penetrates it in one or another form, it destroys much of the gluten or gelatine, and is so tenacious of its hold that traces of the lime can be found in the best leather, notwithstanding the bating by hen or other manures—a most filthy process—to remove it. Processes known as sweating have been introduced, and are largely used, as being less injurious than liming; with these, fermentation and incipient decomposition are a necessity, the stench of a sweat-pit being enough to disgust any one with this process, even if there were no other objectionable features—one of the worst of which is the danger of destroying the softer portions of the hide before the firmer portions have been sufficiently softened for unhairing. The slimy condition of hides, unhaired by sweating, is so objectionable, however, that some tanners treat them with lime to overcome the evil. The sweating process is more objectionable than liming, but it is preferred because of being less destructive to the gelatine, the presence of which is so essential to making good leather, as it alone is the absorbent of tannin. Decomposition is alike the case in both processes, and carelessness in handling would result in complete destruction; while decomposition, no matter however slight, corrodes the gelatine or natural filling of the skin. After decomposition comes bating, to arrest decay, and acids; when these have done their work, they too must be washed out before the hide is in a fit condition for the tanning liquor. The Carter process for unhairing averts all the evils of liming and sweating. By it the hide is unhaired by being placed in a liquid, which in a few hours loosens the hair and plumps the hide without robbing the skin of a particle of gluten. Yet this unhairing liquor is of so harmless a character that no more injury results to the hands from working in it than though it were the purest of water. The subtle preserving characteristics of this unhairing liquor are shown by the fact that a hide can be fitted for unhairing as easily as by any other known process; yet the hair can be again reset as firmly as it was before being put into the unhairing liquor, provided the hair is perfect. But if there be a spot that has been sweated, or where decomposition has taken place, no matter how slight, the decay will be arrested, but the hair cannot be reset. Fur skins treated by this method can be tanned with the fur on, leaving the leather very fine and the fur firmly set. The fact that the hair can be set as firmly as before tanning commenced, establishes the other fact that this liquor does not decompose the slightest particle of the substance of the hide. The result attained by this process of unhairing is the abolition of decomposition by lime or sweat-pits, and the use of bates, acids, hot liquors, &c. Hides can remain for weeks and months in this liquor without injury. The process is simplicity itself. If dry hides are used, they are softened by being soaked in clean water; the purer the water the better. They are then "broke" over the beam, and thrown into the unhairing liquor. Green hides are washed to remove blood and dirt, and then put into the liquor. The hides are allowed to remain in the unhairing liquor 24 hours, after which they are in a condition to be unhaired, though no harm would result by the hides remaining in liquor for months. The hides are unhaired and fleshed in the usual way, and then thrown into weak liquor in the wheel pit, where they are allowed to remain 24 hours, after which they are tanned in pure liquors in the regular way. There are no destructive lime-pits, no filthy bating, no putrescent sweating, no absorption or corroding of gluten, no acids, no hot liquors—nothing, in fact, that can injure the hide or disgust the workmen. The putrid smell so prevalent with other methods is unnoticed in this, simply because the first act is to cleanse the hide of filth, and put it into a liquor which at once arrests decay, and commences the process of converting raw hides into leather, (*Chem. Rev.*)

Glove-kid.—This branch of leather

manufacture is mainly carried on in Germany, Austria, and France. In Germany and Austria, lamb-skins are principally employed; in France, kid-skins. For fine gloves, the skins of very young animals only can be used. The commonest style of manufacture is as follows:—The soaking of the dried skins is effected in large wooden tubs, and occupies on the average 3 or 4 days, according to the character of the soak-water, the size of the skins, and the time they have been stored. The skins, when thoroughly and uniformly softened, are unhaired either by painting the flesh side with a thin paste of lime, or in lime-pits. In unhairing by painting, the skins, after coating the flesh side with lime, are folded together, so that the lime comes as little as possible into contact with the wool, and these bundles or "cushions" are placed in a tub, in which they are most frequently covered with water. After unhairing on the beam with a blunt knife, the skins must be limed for some days, in order that the leather may stretch well, a quality which the Germans denominate *Zug*. By this method of unhairing, the wool is preserved uninjured, but it is not suitable for the finer sorts of leather. The unhairing in lime-pits is done either with gas-lime, or, as is now almost exclusively the practice, with the so-called "poison-lime." This is prepared by mixing red arsenic (arsenic sulphide) with lime, while it is being slaked, and is at its hottest. The calcic sulphydrate (and perhaps sulpharsenite) thus formed hastens the unhairing, and gives the grain a higher gloss. Well-conducted establishments now avoid as much as possible the use of old limes, which produce a loose, porous leather, with a rough, dull grain. The liming lasts on the average 10 days, and is of the greatest importance. It is essential that the interfibrillary substance shall be dissolved, that the leather may have the quality known as *Stand*, that is to say, may be strongly stretched in either length or breadth without springing back. It also depends upon the liming (and this is of special importance in the case of lamb-skins) whether the tissue of the fat-glands is well loosened, so that the fat, either as such, or as lime- or ammonia-soap, may be readily and completely worked out. Skins in which this is neglected can never be properly dyed.

When the hair (or wool) is well loosened, the skins are rinsed in water, and then unhaired on the beam with a blunt knife. The water employed in washing should not be much colder than the limes, or it will prevent the hair from coming away readily. The wool or hair is washed and dried for sale. The skins are thrown into water to which a little lime-liquor has been added, to prevent precipitation of the lime in the skins by the free carbonic acid of the water, which would have the effect of making them rough-grained.

Next comes the first fleshing or "levelling." By this, the loose cellular tissue on the flesh side is removed, together with the head, ears, and shanks, and the flanks are trimmed. The skins are then again thrown into water, softened with lime-liquor as above described, and then into a bate of dogs' dung. This is prepared by stirring up white and putrid dogs' dung with boiling water, and straining it through a sieve or wicker basket. The bate must be used tepid, and not too strong. The skins "fall" (lose their plumpness) in it rapidly, and become extremely soft and fine to the touch; and the fat-glands, remaining hairs, and other dirt, can now be very readily scudded out. So far, no completely satisfactory substitute has been found for this somewhat disgusting mixture, but it has been noted that guano will produce similar effects. With regard to the mode of action of the dung-bate, much has been speculated without proof, and exact analytical evidence is wanting; but no doubt a weak putrefactive action goes on, as may be deduced from the presence of bacteria; further, the ammonia and weak organic acids present in the putrefying dung are capable of acting on fat and lime; and finally, a direct mechanical effect seems to be produced, difficult to describe, but favourable to the succeeding manipulation. Too strong bates, or too long continuance in them, produces evident putrefactive effects on the skins.

When the skins come out of the bate, they are stretched and worked on the flesh with a sharp knife, and any remaining subcutaneous tissue is removed. This constitutes the second fleshing. They are then rinsed in warm water, and beaten with clubs in a tub, or worked in a tumbler drum, in either case with a very little water only; and finally brought into a tank of water, not too cold, and kept in constant motion with a paddle-wheel.

The skins are next cleansed on the grain-side by working on the beam with plates of vulcanite with wooden handles, so as to remove fat, lime, and ammonia soaps, and other lime compounds, together with all remaining hair or wool. The skins are now a second time washed in the "paddle-tumbler," first in cold and then in tepid water; and after allowing the water to drain from them, they are transferred to the bran-drench.

Bran-drench.—This is prepared by soaking wheaten-bran in cold water, diluting with warm water, and straining the extract through a fine hair sieve. Sufficient of the liquid must be employed to well cover the skins, and the temperature may range from 50° F. (10° C.) to 68° F. (20° C.). These conditions are favourable to bacterial activity, which comes into play, and, on the one hand, evolves formic, acetic, lactic, and butyric acids, which dissolve any remaining traces of lime; and on the other, loosens and differentiates the hide tissue, so as to fit it to absorb the tawing solution. Much care is required in the management of the bran-drench, especially in summer, since the fermentation readily passes into actual putrefaction. The tawing-mixture is composed (like that employed in the fabrication of calf-kid, q.v.) of alum, salt, flour, and egg-yolks, in a quite thin paste. The skins are either trodden in it with the feet, or put into a tumbler-drum with it. Kathreiner pointed out some years since (in vol. 1. of 'Der Gerber'), that a mixture of olive-oil and glycerine might be partially substituted for the egg-yolks in both the tanning and dycing of glove-kid leather.

The tawed skins are now dried by hanging on poles, grain inwards. Rapid drying in well-ventilated, but only moderately-heated, rooms is essential to the manufacture of a satisfactory product. The dry leather is rapidly passed through tepid water, and after being hung for a very short time, to allow the water to drain off, is trodden tightly into chests, and allowed to remain in them for about 12 hours, so that the moisture may be uniformly distributed. It is then trodden on hurdles, composed of square bars of wood joined corner to corner, so as to make a floor of sharply angular ridges. The next operation is stretching over a circular knife, called the *stolmond;* then the leather is dried nearly completely, and slaked again.

Dyeing.—See p. 237.

Imitation Leather.—A mixture recommended consists of 16 parts gelatine and 5 of glycerine. A colouring matter is then added as may be required—caoutchouc to give elasticity, and boiled linseed-oil to render the whole sufficiently flexible. This composition is spread upon linen whilst hot, printed with any pattern desired. The surface is then treated with a solution of alum, sulphate of iron, copper, or zinc. These saline solutions may likewise be mixed with the composition before it is spread on the linen. The surface is lastly varnished, and may be bronzed or gilt. Another composition is obtained by boiling linseed-oil with quicklime and borax, which forms a liquid that, on cooling, becomes a thick paste. It is then mixed with rasped cork and more quicklime.

Morocco Leather. — Morocco leather is produced from goat-skins. Rough-haired or "blue back" seal-skins are also used, and produce an excellent article; while an inferior description, called "French morocco," is produced from sheep-skins. The skins are unhaired by liming in the usual way, and are then bated with a mixture of dogs' dung and water. The tanning is done chiefly with sumach, at first in paddle-tumblers and then in handlers, lasting about a month in all. Sheep-skins are usually tanned through in about 24 hours, by being sewn up into bags, grain side outwards, and nearly filled with strong sumach infusion. A little air is then blown in to completely distend the skin, and they are floated in a sumach bath, and kept moving by means of a paddle. After the first day's immersion, they are thrown up on a shelf, and allowed to drain; they are then again filled with sumach liquor; when this has a second time exuded through the skin, they are sufficiently tanned, and the sewing being ripped open, they are washed and scraped clean, and hung up to dry, making what are called "crust-roans." The dyeing is sometimes done by brushing on a table, grain side upwards, but more usually the skins are folded closely down the back, flesh side inwards, so as to protect it as much as possible from the influence of the colour, and then passed through the dye-bath, which is now generally of aniline colours. The original oriental method of manufacture for red morocco was to dye with cochineal before tanning, and this is still customary in the East, but is quite obsolete in this country. A grain or polish is given to the leather, either by boarding or by working under small pendulum rollers, called "jiggers," which are engraved either with grooves or with an imitation of grain. A well-cleaned sumach-tanned skin is capable of being dyed in the finest shades of colour; and this branch of the manufacture of leather has been brought to great perfection. (Spons' *Encyclopædia.*)

Without doubt, of all the manipulations that skins are subjected to in order to produce fancy leathers, that for the production of morocco leather is the most difficult and interesting. The discovery of the art is comparatively recent, and requires a thorough knowledge, not only of the action of the tannic acid upon the epidermis, but also of chemistry, for the preparation and application of the various colours. It was not until the end of the last century that a factory was established at Choisy (France) for the fabrication of morocco leather; the method employed remained for a long time a secret, it being more simple than the one mentioned by Delalande as existing at Morocco. The red colour that they gave the skins was found to be superior to the genuine article, could resist the astringent action of sumach for many days, and was unaltered by acids; in consequence of this, even at the present day the dyeing of the skins no longer takes place in the Oriental countries, but the skins are sent, under the name of Meschin leather, to be dyed and dressed in Europe. Little by little a variety of reddish colours were produced, but it was not until 1820 that the art of dyeing blue was discovered. About the same year a new kind of morocco was made at Strasburg, having a metallic appearance (obtained with a decoction of logwood and certain salts). After all the above had been accomplished, there were still other difficulties of great importance to be overcome. It was necessary to obtain rapid drying in all seasons. The delicate tints were easily altered by the rain; heat of an oven changed the colours; the only possible drying was in the open air. Fries and Fanler proposed ovens kept at a constant temperature by means of a ventilator.

Morocco leather is made of tanned goat-skins, and its manufacture is an industry in which Philadelphia can justly claim a superiority over any city in the Union; nearly three-quarters of the total number of skins imported are brought to that city to be converted into morocco. The climate and water seem to be well adapted for this purpose. This being a well-known fact, experts from other States and countries have come there to offer their services. The black colour is obtained with acetate of iron; as for the other colours, aniline dyes are made use of.

The number of skins utilized daily varies from 15 to 50 dozen, according to the size of the factory. They all arrive in a dry and hairy state, and are softened by soaking in water for several days, treading them under the feet, and scraping on the fleshy side to produce evenness. They are then placed in lime-pits (these preliminary operations require great care). The hair is easily detached after one month's soaking, then they are scraped on the beam, after which they are placed in a milk of lime, and fleshed with a scraping-knife.

The vatting of the unhaired skins is more important in the manufacture of morocco than any other kind of leather, as a small quantity of lime will often be sufficient to destroy the action of the dye. The French understand the importance of this, and to ensure the skins being well washed after the vatting, they are placed in cylinders one-half filled with water, which revolve on a horizontal axis; afterwards they are frequently placed in a bath of lactic acid; in this manner the lime becomes soluble. The tanning now commences. Sumach in nearly every case is used. The skins are sewn together, and the necessary amount of tanning substance is placed in the interior of the sack thus formed. They are inflated with air, and are then sewn tightly to prevent any escape, and are thrown into a vat containing a shallow depth of a weak solution of sumach, and are made to float during 4 hours, being agitated occasionally in order to secure a uniform action of the sumach. (In England, instead of air, water is employed in the skins.) They are then piled one on the other, the pressure thus produced by their own weight being sufficient to force the tannin through all the pores of the skin. This operation is again repeated, after which the bags are unstitched, scraped on the beam, and placed in the drying-room, which has a direct communication with the open air. When dry, they are again moistened, rubbed with a copper tool to make them smooth, and are again hung up to dry. The skins are now ready to be dyed, which can either be done in a dye-vat or with a brush.

The first takes place in a small trough large enough to hold one skin. The dye is at a temperature of 60°, and is about equal in quantity to the volume absorbed by one skin. They are continually moved to and fro. This dyeing operation is repeated several times, after which they are rinsed, stretched on boards, rubbed smooth, tacked round the edges, washed in water, and dried.

Then the brush is made use of. Two skins are placed together, and are rubbed exteriorly with a brush containing the mordant solution. The colour is applied afterwards in the same manner. The French method of dyeing red consists in sewing the skins flesh against flesh before tanning with sumach. (The mordant must be warm.) About 33 gr. of cochineal per skin are used.

As for other colours, the tanning takes place before the dyeing. The skins of the same colour, after being placed for a short time in the dye-vat, are piled one on the other, and are submitted to the action of a hydraulic press. In this manner the excess of dye-liquor is removed.

The following table gives the chemicals made use of in dyeing skins in order to produce different colours:—

Dyeing in Vat.

Colours obtained.	*Chemicals made use of.*
Prussian Blue.	1st. Diluted solution of nitrate of iron for 1 hour. 2nd. Warm bath containing yellow prussiate of potash and a little SO_2.
Scarlet.	1st. Mordant of chloride of tin and cream of tartar. 2nd. Extracted liquor of cochineal.
Purple.	Extract liquor of cochineal on the top of Prussian blue.
Bronze.	Strong extract of logwood and alum.

Dyeing with a Brush applied Topically.

Colours obtained.	*Chemicals made use of.*
Black.	Solution of acetate of iron.
Crimson.	1st. Mordant of alum or tin salt. 2nd. Decoction of cochineal.

PUCE.	1st. Mordant of alum. 2nd. Decoction of logwood.
BLUE.	Solution of sulphate of indigo.
OLIVE.	1st. Mordant of a weak solution of copperas. 2nd. Decoction of barberry containing a little blue bath.
VIOLET.	Consecutive application of a decoction of cochineal and weak indigo bath.

Skins are classified, and the finest are dyed with red. There are two kinds of morocco—the genuine and the imitation. The difference between the two is that the latter is obtained by the splitting of calf, sheep, and other skins, and is chiefly employed for bookbinding. The preparation of these skins is the same as the above, except after being stripped of their wool they are submitted to a powerful hydrostatic pressure to get rid of oleaginous matter, which would greatly interfere with the tanning. Dyed skins are enhanced by dressing, and the grain given. They are first rubbed on the hair side with linseed-oil, applied by means of flannel; then glazed by machinery, after which the peculiar appearance of the surface is given by rolling the skins on a table under a small weighted roller having a grooved face. (L. S. Ware in *Polyt. Rev.*)

Restoring Morocco Leather. — Find some Judson's dyes the colour you require, and dilute for shade required. When dry, finish with glaire—*i.e.* the white of eggs whipped up and allowed to stand. The liquid is poured off, and this is the article required.

Patent, Japanned, or Enamelled Leather.—These are terms used to designate those leathers, whether of the ox, the horse, the calf, or the seal, which are finished with a waterproof and bright varnished surface, similar to the lacquered woodwork of the Japanese. The term "enamelled" is generally used when the leathers are finished with a roughened or grained surface, and "patent" or "japanned" are the terms used when the finish is smooth. Though generally black, yet a small quantity of this leather is made in a variety of colours.

(1) Leather destined to be finished in this way requires to be curried without the use of much dubbing, and to be well softened. The English practice is to nail the skins, thus prepared and quite dry, on large smooth boards, fitted to slide in and out of stoves maintained at a temperature of 160° to 170° F. (71° to 77° C.), coating them repeatedly with a sort of paint composed (for black) of linseed-oil, lampblack, and Prussian blue, well ground together. Each coating is allowed to dry in the stoves before the next is applied. The number of coatings varies with the kind of skin under treatment, and the purpose for which it is intended. The surface of every coat must be rubbed smooth with pumice; finally, a finishing coat of oil varnish is applied, and, like the preceding coats, is dried in the stove. The exact degrees of dryness and flexibility, the composition of the paint, and the thickness and number of the coats, are nice points, difficult to describe in writing. This branch of the leather industry, so far as it relates to calf-skins, is carried on to a larger extent, and has been brought to greater perfection, in Germany and France than in England. In the former countries, the heat of the sun is employed to dry some of the coatings. The United States have also brought this style to a high degree of excellence, especially in ox-hides. There, use is made of the oils and spirits obtained from petroleum, and without doubt French and German emigrant workmen have materially assisted in attaining this high standard. Leather finished in these styles is used for slippers, parts of shoes, harness, ladies' waist-belts, hand-bags, &c., and has now maintained a place amongst the varieties of leather for a long period of years. (Spons' *Ency.*)

(2) The first coats of the japan for patent leather are made with linseed-oil and Prussian blue, boiled together for some hours; the last coat or varnish, with linseed-oil and lampblack, simi-

larly boiled. Each coat is separately dried at a temperature of 160° to 180° F. (71° to 82° C.), and rubbed on the leather by the hand, the skin being nailed on to the surface of a board. As the process is a very delicate one, and requires special knowledge in each part of the operation, it would be useless for any one to attempt to produce japanned leather, except as an experiment, for his own amusement, without serving an apprenticeship to the trade. (Bevingtons & Sons.)

(3) To Separate Sides of Patent Leather.—Patent and enamelled leather will, if the glazed sides are placed together in warm weather, become stuck together, and unless carefully separated, the leather will be spoiled. The simplest and best way to separate sides is to place them in a drying or other hot room; when hot, they can be taken apart without injury to the glazed or enamelled surface. If a drying-room is not accessible, lay the sides on a tin roof on a hot day, and they will soon become heated sufficiently to allow their being separated without injury. Any attempt to separate without heating to a high degree will prove a failure.

(4) When the enamel of the leather has chipped off, clean the parts well with fullers' earth and water, and then apply varnish. In the first manufacture, the primary coat is made of pale Prussian blue and the best drying-oil, boiled together. When cold, a little vegetable black is ground up with it, and after application to the leather, it is stoved at a gentle heat, and polished with a piece of fine pumice; a second coat, which consists of the same varnish with some pure Prussian blue mixed with it, is then applied. There are also third and fourth coats applied, the last being made of 2 oz. pure Prussian blue, 1 oz. vegetable black, 1 qt. drying oil, with a little copal or amber varnish. Each coat is stoved, and rubbed with pumice. For the purpose of repairing, use all "last coat," stoving at a heat not exceeding 160° F. (71° C.); but take care that the pigments are carefully ground in the drying-oil, and don't add the amber varnish till the third and last coat.

Russia Leather.—This is tanned in Russia with the bark of various species of willow, poplar, and larch, either by laying away in pits or handling in liquors, much like other light leathers, the lime being first removed by bating, either in a drench of rye- and oat-meals and salt, by dog dung, or by sour liquors. After tanning, the hides are again softened and cleansed by a weak drench of rye- and oat-meals. They are then shaved down, carefully sleeked and scoured out, and dried. The peculiar odour is given by saturating them with birch-bark oil, which is rubbed into the flesh side with cloths. This oil is produced by dry distillation of the bark and twigs of the birch. The red colour is given by dyeing with Brazil-wood; and the diamond shaped marking by rolling with grooved rollers.

Much of the leather now sold as "Russia" is produced in Germany, France, and England. It is tanned in the customary way, occasionally with willow, but more generally with oak-bark, and probably other materials. Economy would suggest the use of such materials as, from their red colour, are objectionable for other purposes, and therefore cheap. The currying is in the usual manner, care being taken that the oil used does not strike through to the grain, which would prevent it taking the dye. The colour is given by grounding with a solution of chloride of tin (100 parts perchloride tin, 30 parts nitric acid, 25 parts hydrochloric acid, allowed to stand some days, and the clear solution poured off, and mixed with 12 volumes of water). The dye-liquor may be composed of 70 parts rasped Brazil-wood, 3 parts tartar, and 420 water, boiled together, strained, and allowed to settle clear. The grounding and dyeing is done on a table with a brush or sponge. The odour is communicated by rubbing the flesh-side with a mixture of fish-oil and birch-bark oil, which sometimes contains no more than 5 per cent. of the latter.

LUMINOUS BODIES.—Luminosity or phosphorescence is a property enjoyed by some organic and inorganic substances of emitting light without heat. These substances are more numerous than is generally supposed.

To commence with organic phosphorescence.

Flowers of a bright yellow or red colour, as the pot marigold (*Calendula officinalis*), the great Indian cress (*Tropæolum majus*), *Lilium bulbosum*, and the *Papaver orientale*, are especially noticeable as having this property, which is observable on fine summer evenings a little after sunset. The luminosity in these flowers, however, is only of very short duration; but some plants, as the pocan or Virginian poke (*Phytolacca decandra*), shine with a faintly luminous continuous light, which is sometimes of a bluish-green and sometimes of a yellowish-green light; also the freshly-drawn juice of the Cipe de Cananum, a Brazilian plant, which will often shine for several hours.

Cryptogamic growths are also in some cases phosphorescent, often to be noticed in vaults where dead bodies are deposited, and also in the *Rhizomorpha phosphorens*, often found in the mines of Hesse, which exhibits a brilliant light when broken. The *Rhizomorpha subterranea* and certain other underground plants are also luminous; most woods, too, can be rendered phosphorescent if sufficiently decomposed and dry. This will account for the faint flickering light often to be noticed in copses and woods during autumn. The animal world abounds in living phosphori, belonging both to the land and water. The light has, it is asserted by some writers, been seen hovering about the heads and ears of horses, and even in a few rare instances of some children. The cause of this has given rise to much speculation, and some attribute it to electricity, and others to the slow combustion of phosphuretted hydrogen; the latter explanation seems most probable, though it cannot be said that either theory is incontrovertible; in these instances, however, the light is only of accidental occurrence. There are, however, animals in whom phosphorescence forms an essential part of their vital economy; such, for example, is the common glowworm (*Lampyris noctiluca*) and congeners, whose brilliant little gems of yellow light so plentifully besprinkle the hedgerows in June. With regard to this last insect, it is interesting to remark that while the male is a coleopterous insect, the female is apterous. The light of this little insect is far outshone in tropical countries by the dazzling lantern-fly (*Fulgora lanternaria*) of South America, of the order *Hemiptera*, which is often nearly 4 in. long, whilst its luminous organ is a kind of proboscis about 1 in. long. Two or three, it is said, of these remarkable creatures are sufficient to light up a good-sized room. The firefly (*Elater noctilucus*) is an interesting insect, together with its two congeners, *Elater phosphorens* and *Elater ignitus*. Another interesting phosphorescent insect often overlooked is the electric centipede (*Scolopendra electrica*). This, though very common in Britain, is rarely noticed, as it seldom leaves its hole during the night, but when it does it leaves a palpable luminous track behind, which continues phosphorescent some little time.

The cause of the light of the glowworm and similar insects has given rise to much conjecture and various theories. All doubt on the subject, however, seems now—thanks to Dr. Phipson—to be pretty well cleared up. Dr. Phipson has shown that in all cases of phosphorescent animals, both sea and land, the luminous principle is a fluid organic substance, which he calls "noctilucine," and which is totally distinct from any solution of phosphorus in oil or other medium, and which will continue to shine after being extracted from the animal; it is a fluid organic substance containing nitrogen, and is produced in luminous animals by special organs, as the animal may require it. This noctilucine, it must be understood, is produced by both aquatic and land animals, and thus readily accounts for the luminous appearance of the sea, caused by numerous wonderful animalcula, and other inhabitants of the watery world belonging to the mollusca, vermes, crustaceæ, and other curious zoophytes. This latter phenomenon has long been misunderstood, and was thought at one time to be due, in some inexplicable way, to electricity, and later was attributed to putrescent particles of organic matter in the water.

Many have asserted that, when the sea is phosphorescent, it is indicative of a coming storm. Baird emphatically denies this assertion, but on the contrary conceives that the animalculæ, &c., causing the luminosity, retire from the surface on change of weather. Dr. Macculloch noticed in the course of his investigations that the sea did not phosphoresce when of a blue colour, and also that the light was most brilliant when the wind was in the E. and S.E. The *Nereis noctiluca*, discovered by Vianelli, is an inhabitant of every sea, and is an active agent in the production of phosphorescence, and it is the multitudes of the minute *Noctiluca miliaris* which causes the oft-remarked luminosity of the English Channel. The first phosphorescent aquatic animal of which we find record is one mentioned in Pliny's writings—the *Pholas dactylus*, which caused the ancients much wonder, as it was said to render luminous the mouths of those who partook of it. It is a species of chonchiferous mollusca, protected by a testaceous shell. To Sir J. Banks we owe the knowledge of two other interesting luminous sea animals—viz., the *Cancer fulgens* and *Medusa pellucens*, both of which were discovered on the coast of Brazil.

The luminous properties of minerals have received from men of science a good deal of attention, and have led in consequence to the elucidation of many interesting facts. Margraaf has ascertained that all the earthy sulphates, when calcined, exhibit this property, and that the metals, metallic ores, and agates are not phosphorescent; the former portion of the discovery had already been partly made known by a shoemaker of Bologna named Vincenzo Cascariola, the inventor of the famous Bolognian stone, which is prepared by strongly heating heavy spar (sulphate of baryta) with gum tragacanth. Most of the minerals having phosphorescent properties only exhibit them after insolation or exposure to the sun. Of these the following are good examples: the diamond and several other precious stones; the Bolognian stone, mentioned above; Canton phosphorus, prepared from water-worn oyster shells, calcined with sulphur; it appears on the mass as a white coating, which is scraped off, and should be kept in stoppered bottles. Dr. Fry, in 1874, found similar properties in gypsum, marble, and chalk; and Baldwin, of Misnia, in 1677, discovered that the residue of chalk in nitric acid was similarly affected. Some even go so far as to assert that all minerals containing a fixed acid are capable of becoming phosphorescent by insolation or other means. Fused nitrate of calcium and petrifactions are also rendered luminous by this means. It is a fact worth noting that insolation affects the phosphorescence best in badly-conducting minerals.

Phosphorescence has been noticed, too, in the change from the amorphous to the crystalline state, and separation of crystals from a solution. Another source of this light, and one not often noticed, is that caused by mechanical means, either percussion or friction; the phosphorescence, however, in this case, lasts only so long as the disturbing influence is at work. Among the substances that are mentioned as affected by this agency, the most characteristic is adularia, a transparent variety of potash felspar (orthoclase) which is found in fine crystals in Cornwall, and also at St. Gothard, in the Alps. This remarkable mineral, when struck so as to split, shows at each crack a streak of light which may last some little time, and when ground in a mortar has the property of appearing to be on fire. Quartz, fluorspar, and rock-salt, also exhibit this property when pounded, but in a far less degree than adularia. In the great majority of cases, the duration of the phosphorescence in natural bodies is extremely short; but, nevertheless, Becquerel invented a most ingenious instrument, which he called a "phosphoroscope," which will measure the length of the existence of the most short-lived phosphorescent flash. An interesting and remarkable discovery was made by Beccari, of Turin, who found that a phosphorescent body gave out in many cases the light to which it had been subjected. This ingenious philosopher also discovered that snow could be rendered slightly luminous by insolation. Some specimens of zinc-blende also give out phosphorescent light, even with so slight an exciting cause as the friction of a feather; and also some kinds of marble show, when heated, a yellowish phosphorescence. (G. R. T., in *Eng. Mech.*)

The luminosity of minerals has an obvious practical value in the case of such substances as can be conveniently applied in the form of a paint to surfaces which are alternately exposed to light and darkness, such exposed surfaces emitting at one time the light which they have absorbed at another. Familiar illustrations are street plates, buoys, and interiors of railway carriages having to traverse many tunnels. The light absorbed may be either daylight or powerful artificial light. With this object, several compositions are prepared under the generic name of luminous paints. They are chiefly as follows:

(1) Balmain's.—This consists of a phosphorescent substance introduced into ordinary paint. The phosphorescent substance employed for the purpose is a compound obtained by simply heating together a mixture of lime and sulphur, or substances containing lime and sulphur, such as alabaster, gypsum, &c., with carbon or other agent to remove a portion of the oxygen present; or by heating lime in a vapour containing sulphur. In applying this phosphorescent powder, the best results are obtained by mixing it with a colourless varnish made from mastic and turpentine; drying oils, gums, pastes, sizes, &c., may, however, also be used.

(2) A French compound. 100 lb. of a carbonate of lime and phosphate of lime produced by the calcination of sea-shells, and especially those of the genus *Tridacna* and the cuttle-fish bone, intimately mixed with 100 lb. of lime rendered chemically pure by calcination, 25 lb. of calcined sea-salt, 25 to 50 per cent. of the whole mass of sulphur, incorporated by the process of sublimation, and 3 to 7 per cent. of colouring matter in the form of powder composed of mono-sulphide of calcium, barium, strontium, uranium, magnesium, aluminium, or other mineral or substance producing the same physical appearances, *i.e.* which, after having been impregnated with light, becomes luminous in the dark. After having mixed these five ingredients intimately, the composition obtained is ready for use. In certain cases, and more specially for augmenting the intensity and the duration of the luminous effect of the composition, a sixth ingredient is added in the form of phosphorus reduced to powder, which is obtained from seaweed by the well-known process of calcination. As to proportion, it is found that the phosphorus contained in a quantity of seaweed, representing 25 per cent. of the weight of the composition formed by the five above-named ingredients, gives very good results.

The phosphorescent powder thus obtained and reduced into paste by the addition of a sufficient quantity of varnish, such as copal, may serve for illuminating a great number of objects, by arranging it in more or less thick coatings, or by the application of one or more coatings of the powder incorporated in the varnish, or by varnishing previously and sprinkling the dry powder upon the varnish. The amount of powder applied should not exceed the thickness of a thin sheet of cardboard.

The dry phosphorescent powders are also converted into translucent flexible sheets of unlimited length, thickness, and width, by mixing them with about

80 per cent. of their weight of ether and collodion in equal parts in a close vessel, and rolling the product into sheets with which any objects may be covered which are intended to be luminous in the dark. The powders may also be intimately mixed with stearine, paraffin, rectified glue, isinglass, liquid silex, or other transparent solid matter, in the proportion of 20 to 30 per cent. of the former with 50 to 80 per cent. of either of these substances, and this mass is then reduced into sheets of variable length, width, and thickness, according to their intended applications. A luminous glass is also manufactured by means of the powders by mixing them in glass in a fused state in the proportions of 5 to 20 per cent. of the mass of glass. After the composition has been puddled or mixed, it is converted into different articles, according to the ordinary processes; or after the manufacture of an object still warm and plastic, made of ordinary glass, it is sprinkled with the powders, which latter are then incorporated into the surface of the article by pressure exerted in the mould, or in any other suitable way.

It has been observed after various trials that the passage of an electric current through the different compositions augments their luminous properties or brilliancy to a great extent; this peculiarity is intended to be utilized in various applications too numerous to describe; but of which buoys form a good example. The current of electricity is furnished by plates of zinc and copper mounted on the buoy itself, when the latter is used at sea; but in rivers and fresh-water inlets the battery will be carried in the interior of the buoy. To secure the full effect, 10 to 20 per cent. of fine zinc, copper, or antimony dust is added to the phosphorescent powder described.

(3) Take oyster-shells and clean them with warm water; put them into the fire for ½ hour; at the end of that time take them out and let them cool. When quite cool, pound them fine, and take away any grey parts, as they are of no use. Put the powder in a crucible with alternate layers of flowers of sulphur. Put on the lid, and cement with sand made into a stiff paste with beer. When dry, put over the fire and bake for an hour. Wait until quite cold before opening the lid. The product ought to be white. You must separate all grey parts, as they are not luminous. Make a sifter in the following manner: Take a pot, put a piece of very fine muslin very loosely across it, tie around with a string, put the powder into the top, and rake about until only the coarse powder remains: open the pot, and you will find a very small powder. Mix it into a thin paint with gum water, as two thin applications are better than one thick one. This will give paint that will remain luminous far into the night, provided it is exposed to the light during the day.

(4) Sulphides of calcium, of barium, of strontium, &c., give phosphorescent powders when duly heated. Each sulphide has a predominant colour, but the temperature to which it is heated has a modifying effect on the colour. Calcine in a covered crucible, along with powdered charcoal, sulphate of lime, sulphate of barytes, or sulphate of strontia; there is produced in each case a greyish white powder, which, after exposure to strong light (either sunlight or magnesium light), will be phosphorescent, the colour depending on the sulphate used and the degree of heat employed.

(5) Five parts of a luminous sulphide of an alkaline earth, 10 of fluorspar, cryolite, or other similar fluoride, 1 of barium borate; powdered, mixed, made into a cream with water, painted on the glass or stone article, dried, and fired in the usual way for enamels. If the article contains an oxide of iron, lead, or other metal, it must be first glazed with ground felspar, silica, lime phosphate, or clay, to keep the sulphur of the sulphide from combining with the metal. The result is an enamelled luminous article. (Heaton and Bolas.)

(6) Boil for 1 hour 2¼ oz. caustic lime,

recently prepared by calcining clean white shells at a strong red heat, with 1 oz. pure sulphur (floured) and 1 qt. soft water. Set aside in a covered vessel for a few days; then pour off the liquid, collect the clear orange-coloured crystals which have deposited, and let them drain and dry on bibulous paper. Place the dried sulphide in a clean graphite crucible provided with a cover. Heat for ½ hour at a temperature just short of redness, then quickly for about 15 minutes at a white heat. Remove cover, and pack in clay until perfectly cold. A small quantity of pure calcium fluoride is added to the sulphide before heating it. It may be mixed with alcoholic copal varnish. (*Boston Jl. Chem.*)

MAGNESIA.—This, the only known oxide of magnesium, is ordinarily prepared by the gentle and prolonged ignition of magnesium carbonate. A new process has lately been opened up, as follows:—

If we cause a solution of magnesium chloride to be absorbed by dry slaked lime, the magnesia set at liberty plays the part of a cement, and the matter may be moulded into small porous fragments. If one of these fragments is suspended in a solution of magnesium chloride, after some days the lime is entirely replaced by hydrate of magnesia. The fragment has been the seat of a double diffusion; the magnesium chloride has diffused itself from without to within, and is changed in the fragment into calcium chloride, which in turn becomes diffused from within to without. These two diffusions are simultaneous, and come to an end when all the lime has been replaced by magnesia. Here, then, is a means of reducing into a small volume a precipitate which would have occupied the entire bulk of the solution, if the fragment of lime had been stirred up in it at first. The same phenomena are produced if a great number of such fragments are heaped up in a suitable vessel, where a solution of magnesia is made to circulate slowly from the top to the bottom. In 5 or 6 days the conversion is complete; the solution may be replaced by pure water, and the magnesia washed completely. On stirring up, it becomes a white pulp, which, if dried in the air, gives a very friable mass. It is hydrated magnesia, which may remain for a long time exposed to the air without becoming notably carbonated. Its purity depends on that of the lime employed. In working on the large scale, the author uses a paste of lime, which he forces through a plate of metal pierced with small holes, so as to eliminate stones and unburnt pieces. If these "worms" fell upon the ground or into water, they would at once return to their pasty state. He therefore receives them in a solution of magnesium chloride, where they become at once covered with a slender coating of magnesia, which consolidates them so well that they may be heaped up to the height of 5 ft., still leaving between them the interstices needful for the circulation of the liquid. The paste of lime should contain 34 to 36 per cent. of anhydrous lime. The solution of magnesian salt should contain 25 to 40 grm. of anhydrous magnesia per litre. The laws of diffusion laid down by Graham are here at fault. The acceleration of the phenomena due to an increase of strength, is balanced by the resistance opposed by a more consistent deposit of magnesia. The presence of sodium chloride, always abundant in the water of salt marshes, is indifferent. Soluble sulphates must be removed by adding the water from a former operation, rich in calcium chloride, and allowing the calcium sulphate to settle, after which the clear liquor is run off for treatment. (*Chem. News.*)

MATCHES.—Matches consist of two essential parts, a stem (which may or may not be combustible) and an igniting composition.

In the case of common matches, the stem is made of wood. The wood most generally used is soft pine, which is sawn into blocks to fit the machine. The wood, having been cut into splints, is taken out and tied up into bundles of a thousand each, and then thoroughly dried by being left in a heated chamber for some time. The next process is ordinarily to dip the ends in melted sulphur, which is commonly done by hand, the dipper giving to the bundle a kind of twist which makes the ends spread out a little, so that they get coated all round with the sulphur, and do not stick together in cooling. Each end is dipped in turn, and, when dry, the bundles are cut through the middle by a circular saw. The object of dipping them first in sulphur is to supply a substance which will readily take fire on the ignition of the compound with which the end is afterwards tipped. The fumes of burning sulphur are, however, disagreeable, and some matches are therefore made without it. In this case, the ends of the splints are slightly carbonized by pressing them for a moment upon a plate of red-hot iron, and then just touched with some melted stearine or paraffin, a small quantity of which is at once absorbed by the wood. These burn even better than the preceding, as the wood then takes fire immediately, while in the others it does not until the sulphur is nearly burnt out. The stearine or paraffin is more expensive; but, on the other hand, a much less quantity will answer the purpose, and the matches so made are altogether preferable for the consumer.

The next step is to apply the material which is to be the source of fire, and which must be of such a nature as to take fire readily with moderate friction. This composition is made up into a pasty mass, the most important ingredient being phosphorus; but both the proportions and the subsidiary articles vary greatly in different manufactories. The object is to make a paste which, when dried, will not be affected by exposure to the atmosphere, which may be readily ignited with moderate friction, and which shall be sufficiently tenacious to adhere firmly to the end of the splint until the wood has taken fire. Ordinary phosphorus cannot be preserved in a dry condition in the air, as it rapidly oxidizes and takes fire spontaneously, emitting very poisonous fumes at the same time. It has therefore to be kept constantly under water, and, except in combination with other substances, would be most unsuitable for domestic use. Chlorate of potash, which is a highly-explosive substance, is free from some of the objections attaching to phosphorus, and it is substituted for it by some makers. Most, however, use a little of each in their paste. The worst feature of the chlorate of potash is its readiness to explode on a very slight concussion, the violence of its action throwing off sparks which might prove dangerous. Matches containing much of this article may be recognised by the sharp detonation with which they go off; those which are called "noiseless" contain no chlorate of potash. These are the two principal light-bearing ingredients. The rest are glue or gum, to give them coherence; some fine sand or pulverized glass, to give increased friction; and some substances which will readily give up a large amount of oxygen—such as nitrate of potash, the peroxides of lead or manganese, and sulphide of antimony—to promote rapid ignition. Some mineral colouring matter is added, according to the fancy of the manufacturer. It will be quite unnecessary to go into detail as to the relative proportions which may be used, for they may be varied almost infinitely. Even the most important article of all, the phosphorus, varies in quantity from 5 to 50 per cent. The larger proportions are generally to be found in those which contain no chlorate of potash.

The matches made on the Continent are compounded with gum; but in England, glue is generally used, because of the greater humidity of this climate. The plan adopted in mixing the ingredients is as follows:—The glue is broken into small pieces and put into cold water, in which it is left to soak for some time; it is then boiled up gently until thoroughly dissolved. The pot is then taken off the fire, and the required proportion of phosphorus is gradually added. It melts immediately with the heat of the watery glue; but it must be kept constantly stirred to make it mingle thoroughly, care being taken to keep it below the surface of the liquid. The other articles are then added, and the stirring is maintained with vigour, as the compound thickens both with the cooling and with the addition of the solid ingredients; it must, however, be kept in a pasty condition, and therefore the temperature is not allowed to fall below about 97° F. (36° C.). The paste is then spread in a thin layer upon a flat table of marble or iron, which is kept just sufficiently warm to maintain the glue in a soft condition until the dipping has taken place. If gum be used instead of glue, no artificial heat is required at this stage of the process, as it will not solidify by cooling. The paste is spread evenly upon the table to an exact depth, so that in dipping the matches one shall not get a larger share of the composition than another. After dipping, they are left to dry for 3 or 4 hours in the air, and then are placed for 2 hours in a heated chamber, the temperature of which is maintained at 80° to 90° F. (27° to 32° C.). The matches are by this time finished and ready for packing.

The question whether or not "safety matches" will ignite when rubbed on other surfaces than "the box" has been practically settled in the affirmative, but under such circumstances that the fact does not detract from their merit as "safety" matches. The answer to the question would seem to depend entirely on whether the surface on which the match is rubbed is capable of imparting sufficient heat by friction to fire the paste with which the end is tipped. Linoleum has been found to answer, and W. Preece recently stated that the matches would light on ebonite. C. Tomlinson, F.R.S., states, in a recent number of *Nature*, that he has succeeded in igniting safety matches by friction against glass, an ivory paper-knife, a steel spatula, zinc, copper, marble, and a fresh-cleaved surface of slate. For the sake of strength, two matches should be taken and held close to the tipped end, and they must be rubbed with some degree of pressure.

The readiness with which the match ignites by friction, says Tomlinson, depends greatly on the nature of the surface. Lead is too soft and tin too smooth. The metals produced by rolling have a sort of skin on the surface, over which the match glides without sufficient friction, but if the surface of zinc be rubbed with sand-paper, or with a fine file, it becomes active in firing the match. He noticed that the polish of his ivory paper-knife became worn before it acted well. Nor is it very easy to fire the match on glass. A long sweep repeated about a dozen times with considerable pressure seems to be necessary. The two specimens of sheet copper used by him had a sort of grain which was favourable to the success of the experiment. The copper acted equally well whether the surface was dirty or cleaned with dilute sulphuric acid. After rubbing a match 10 or 12 times on zinc, without effect, the same match rubbed on copper immediately took fire. As a rule, it may be taken that polished surfaces will not ignite the matches until the polish itself is destroyed by the friction.

In the case of slate, lead, tin, and some other surfaces, the composition on the match acts as a polish, and thus renders it unfit for ignition. On the other hand, a finely-cut file removes the composition from the end of the match without igniting it.

He thinks that many other surfaces might be found on which the safety matches would ignite with greater or less difficulty. Notwithstanding this, the match is still a safety match, although it does not fulfil the statements made on the box. It does not ignite readily on any of the surfaces pointed out, except copper and marble (unpolished), but it does ignite with wonderful facility when rubbed against the side of the box.

Ordinary matches made with phosphorus were during many years dangerous contrivances. They were luminous in the dark, liable to ignition on a warm mantelpiece, poisonous—children have been killed by using them as playthings; and, moreover, they absorbed moisture, and became useless by age. But the chief inducement in getting rid of ordinary phosphorus and substituting the new variety was to put an end, as far as possible, to the "jaw disease" to which the workmen were subject. The red or amorphous phosphorus gave off no fumes, had no smell, was not poisonous, and the matches made with it were not luminous in the dark; they did not fire on a warm mantelpiece, did not contract damp, and would keep for any length of time. But there was a difficulty. When red phosphorus is brought into contact with potassic chlorate, a slight touch is sufficient to produce an explosion, in which the red phosphorus reassumes its ordinary condition. Many attempts were made to form a paste, and many accidents and some deaths occurred in consequence. At length the happy idea occurred to a Swedish manufacturer not to attempt to make a paste at all with the red phosphorus, but to make the consumer bring the essential ingredients together in the act of igniting the match.

Vestas.—In making wax vestas, the first process is the coating of the cotton. A number, say 20, of strands or wicks, composed of 15 to 20 threads each, are led from a bale placed upon the ground, through guides arranged overhead, down into an oval steam-jacketed pan, filled with wax composition, underneath a presser arranged in the centre of a pan, and through a draw-plate pierced with holes of the required gauge of the match-body; thence it is led some 15 or 16 ft. over a drum 5 or 6 ft. in diameter, and then to a similar drum on the opposite side of the bath, from which it is repeatedly passed through the paraffin, wooden guides being arranged to support the wick wherever necessary. The distance traversed after the cotton has passed through the bath is made as long as possible, since the composition neither dries so readily, nor adheres so uniformly to the strand, as in the after-dipping. It is passed and repassed about 6 times through the bath, until the wax coating is of sufficient thickness, and just passes the holes in the gauge-plates. Considerable care is necessary to ensure evenness in the first coating, and to watch against broken threads.

The drum has a metallic plate on one part of its circumference, and here the wax taper is cut into lengths of the circumference of the drum, is tied in bundles, and is carried to the table having partitions to hold each bundle of lengths. The lengths are pressed against a gauge, and cut up by means of a knife working on a pivot. The match-bodies so cut off are carefully transferred to shallow zinc frames, constructed of the required depth, and made with a lid which is slid down when the frame is filled; they are then carried to a filling-machine of a small size, and usually worked by hand. Here they are filled into dipping-frames in the same way as ordinary matches, the machine having its hopper arranged to suit the size of the bodies. Wax matches can be dipped in the same way as those of wood; but some years since, S. A. Bell devised a machine in which frames are attached to two chains running on either side of guides. Between them, a flannel roller revolves in a pan of liquid composition. The frames, with the splints arranged downwards, run over this roller, and the composition is thereby added to the bodies with considerable regularity and dispatch. The machine will dip 3500 to 4000 frames a day, and since each frame holds about 4500 splints, it will dip about 18,000,000 splints in that time. The drying is effected, when practicable, in the open air, the frames standing together in twos or fours. At other times, the splints are dried by hot air, distributed by means of revolving fans, in rooms set apart for the purpose. After drying, they are sorted and packed in boxes of various size, pattern, and capacity.

Vesuvians.—The "vesuvians," principally used as lights by smokers, have rounded splints, made from alder, or some similarly hard wood, the object being to prevent the ignition of the wood, and consequent dropping of the burning composition. The more expensive kinds are made on glass bodies, consisting of glass piping of small section, which is chiefly procured from Italy, and should yield some 1200 splints to the lb. J. W. Hunt and Co., of London, have an ingenious method of retaining the composition by means of a piece of wire, about ⅓ in. long, inserted by hand into the end of each splint; it answers the purpose effectually. The vesuvian-splints are placed by hand into the dipping-frames, dipped twice or three times into the burning composition, until the head is of sufficient size, and then finally dipped into the igniting composition, in the same way as an ordinary match, an interval being allowed between the operations, for drying.

Compositions.—Igniting compositions are generally manufactured of some form of phosphorus mixed with oxidizing agents, with which it will readily inflame by friction. Such are saltpetre, chlorate of potash, and red-lead; these are mixed up with glue, which causes them to adhere to each other and to the wooden splints. Most makers have a particular mixture of their own; the following practical recipes may be taken as fairly representative, the first being the best:—(1) ½ part by weight phosphorus, 4 chlorate of potash, 2 glue, 1 whiting, 4 finely-powdered glass, 11 water; (2) 2 parts by weight phosphorus, 5 chlorate of potash, 3 glue, 1½ red-lead, 12 water.

The Germans replace the chlorate either by nitrate of potash or nitrate of lead, together with red-lead, hence their matches strike silently, without the short detonation peculiar to English goods.

The match composition is coloured either with a coal-tar colour, ultramarine blue, Prussian blue, or vermilion. In preparing the composition, the glue and the nitre or chlorate of potash are dissolved in hot water, the phosphorus is then added, and carefully stirred in until intimately mixed, the whole being kept at a temperature of about 100° F. (38° C.). The fine sand and colouring matter are then added, and the mixture is complete.

(3) Dipping composition for safety-matches consists of 1 part by weight chlorate of potash, 2 glue, 1 sulphide of antimony, 12 water. For the rubber on the box, 2 parts of amorphous phosphorus and 1 of powdered glass are mixed with the solution of glue, and painted on the box.

Vestas are tipped with similar ingredients, but the taper being less rigid than wood, a larger proportion of phosphorus is added.

(4) Matches from Sweden were found to be tipped with an igniting composition made up of the following substances:—

	In 100 parts.
Glass	8·77
Glue	7·12
Potassic bichromate .	5·59
Potassic chlorate . .	46·76
Ferric oxide . . .	4·09
Manganese	13·07
Sulphur.	7.41

It is supposed that the following proportions were employed in the manufacture of the composition:—

Glass	1¼ lb.
Glue	1 „
Potassic bichromate .	⅘ „
Potassic chlorate . .	6¾ „
Ferric oxide . . .	½ „
Manganese . . .	2 „
Sulphur	1 „

In consequence of the small proportion of oxygen-yielding substances to sulphur, a large quantity of sulphurous acid is evolved on igniting the mass.

(5) In another composition, likewise from Sweden, Wiederhold found to 1 of sulphur 21 of potassic chlorate; this composition yielded no free sulphurous acid, the sulphur being wholly oxidized to sulphuric acid. (*Dingler's Polyt. Journ.*)

(6) English Matches.—2 parts fine glue soaked in water till quite soft, 4 parts water, heated together in a water-bath till quite fluid; remove the

vessel from the bath, and add 1½ to 2 parts phosphorus, agitating the mixture briskly and continually with a stirrer having wooden pegs or bristles projecting beneath. When the mass is uniform, 4 or 5 parts chlorate of potash, 3 or 4 parts powdered glass, and sufficient colouring matter in the form of red-lead, smalts, &c., are cautiously added, and the whole is stirred till cool.

(7) Silent Matches.—Dissolve 16 parts gum-arabic in least possible quantity of water, triturate in 9 parts powdered phosphorus, and add 14 parts nitre, 16 parts vermilion or binoxide of manganese, and form the whole into a paste.

(8) 6 parts glue soaked in a little cold water for 24 hours, and liquefied by trituration in a heated mortar; add 4 parts phosphorus, and rub down at a heat not exceeding 150° F. (66° C.); mix in 10 parts powdered nitre, and then 5 parts red ochre and 2 parts smalts, and form the whole into a uniform paste.

(9) Instead of phosphorus, lead sulphocyanate mixed with precipitated antimony sulphide is treated in the moist state with an oxygenous substance, such as potassium chlorate, with indifferent colouring and rubbing agents, such as glass, quartz, pumice powder, ultramarine, &c., and with glutinous substances, such as glue, gum, and dextrine. The mixture is used in place of the materials employed for igniting sulphur matches, wax lights, &c. (H. Schwarz.)

(10) The following is the recipe given by Berzelius:—Weigh out 30 parts of powdered chlorate of potash, 10 of powdered sulphur, 8 of sugar, and 5 of gum-arabic, with a little cinnabar to communicate colour. The sugar, gum, and salt are first rubbed together into a thin paste, with water. The sulphur is then added, and the whole being thoroughly beaten together, small brimstone matches are dipped in, so as to retain a thin coat of the mixture upon their sulphured ends. When quite dry, they are fit for use.

(11) The heads of vesuvians are made up principally with powdered charcoal and saltpetre in some such proportions as the following:—18 parts saltpetre, 19 charcoal, 7 powdered glass, 5 or 6 gum-arabic; to these ingredients are added a little scent, in the form of satin-wood, lignum-vitæ dust, cascarilla bark, or gum benzoin, which render them fragrant while burning. The igniting composition is identical with (1) or (2).

PAPER.—The following notes on papermaking are condensed from Dunbar's valuable little work called the 'Practical Papermaker.' Those desiring a more exhaustive and scientific account of this industry should refer to Spons' 'Encyclopædia.'

Selection and Assortment of Rags.—Rags are brought to the mill in an unsorted condition, and are called "mixed." The system of assorting and classifying rags in common use in this country, and the distinguishing mark given to each sort, cause considerable confusion.

The superiority of the Continental system is very marked. There the rag department consists of a 2-storey building; on the ground-floor the cutting and sorting is done; the upper storey is fitted up with 20 stalls or compartments, numbered from 1 to 20. The rags, cut and overhauled, are hoisted to the second flat, and deposited according to quality in the numbered compartments, and thence taken to the willows in quantities of the various sorts to make up the desired stuffs. The rags are known by number as follows:—

No. 1 rags, white linen without seams, fine clean; No. 2, white linen with seams, fine clean; No. 3, white linen with seams, second quality; No. 4, white linen with seams, third quality (the three last-mentioned qualities are easily distinguished, for as the quality deteriorates the rags become thicker, and the thicker the rags, the greater the quantity of sheive they contain); No. 5, blue linen without seams, first quality; No. 6, blue linen with seams, second quality; No. 7, blue linen with seams, third quality; No. 8, good linen, seconds; No. 9, coarse linen, seconds; No. 10, white cotton, fine, first quality; No. 11, white cotton, second quality;

No. 12, coloured cotton, third quality; No. 13, sailcloth without seams, first quality; No. 14, sailcloth with seams, second quality; No. 15, fine hemp bagging, good clean; No. 16, good hemp bagging; No. 17, hemp rope, fine clean; No. 18, hemp rope, good clean; No. 19, hemp rope, free from tar, third quality; No. 20, broke from all the above except the rope.

The simplicity and efficiency of this method are evident; the higher the number is, the coarser the quality of the rags: No. 1 is the equivalent for S.P.F.F.F.

Blending the rags for different stuffs suitable for various qualities of paper requires great care. A paper of a certain quality is desired: the difficulty is to blend that proportion of cotton with linen rags which will produce a paper, tough, strong, well-sized, and possessing those elastic qualities which will permit it to be folded into any shape without showing signs of cracking, as is especially necessary in book papers. The most convenient and efficacious mode is to form the various rags into stuffs, composed as follows:—

No. 1 Stuff.

No. 2 rags . .	1200 lb.
" 5 " . .	2800 "
	4000 lb.

No. 3 Stuff.

No. 4 rags . .	400 lb.
" 6 " . .	1200 "
" 8 " . .	2400 "
	4000 lb.

No. 1 and No. 3 stuffs are for specially strong papers.

No. 4 Stuff.

No. 7 rags . .	1600 lb.
" 9 " . .	2800 "
" 20 broke . .	400 "
	4800 lb.

If broke accumulates, a larger proportion can be used in making coloured papers, otherwise the above quantity is sufficient. Rags Nos. 10, 11, and 12 are specially reserved for blending, for thick papers, or for printings of a high class. Nos. 13, 14, 15, and 16 supply the place of any of the numbers for which they are suited. No. 1 can be drawn upon in the event of a special paper being desired.

No. 5 Stuff.

No. 6 rags . .	1600 lb.
" 8 " . .	2400 "
	4000 lb.

No. 5 stuff is principally used for mixing with rope stuff for tissue and copying papers, in proportions given in recipes for thin papers.

Rope Stuff.

No. 17 ropes, . .	2600 lb.
" 18 " . .	1200 "
" 19 " . .	200 "
	4000 lb.

The qualities of paper on the Continent are known by numbers, No. 1 being the highest quality of writings and printings. The qualities of paper that can be made from the various stuffs are—

From No. 1 stuff,	extra superfine or No. 1 papers.
" 3 "	superfine and fine papers,
" 4 "	fines, fourths, and coloured papers.
" 5 "	thin papers; also used for mixing with the rope stuff, for cigarette, copying, and tissue papers.

The classification of home and foreign rags, according to the method generally adopted in this country, is:—Superfines, S.P.F.F.F., S.P.F.F., S.P.F., dark fines, grey or green linen, new pieces, sailcloth, F.F., L.F.X., C.L.F.X., C.C.L.F.X., fines, seconds, thirds, cords both dark and light, outshots, prints, and the various qualities of hemp and jute bagging.

Superfines consist of superfine new white shirt cuttings; S.P.F.F.F., extra superfine white linen, first quality; S.P.F.F., superfine white linen, second quality; S.P.F., fine white linen, third quality; dark fines, fine white cotton rags, well adapted for blotting-paper of a good quality; green linen, fine unbleached linen cuttings; new pieces, fine unbleached linen cuttings; sailcloth, canvas (worn) and new cuttings; F.F., coarse Russian linen rags, first quality; L.F.X., coarse Russian linen rags, second quality; C.L.F.X., coarse Russian linen rags, third quality; C.C.L.F.X., coarse Russian linen rags, fourth quality.

The last four sorts of rags are easily distinguished, as there is a considerable difference in the quality and appearance, the rags being thicker and sheivier as the quality deteriorates.

Fines consist of fine white cottons; seconds, soiled white cottons; thirds, extra dirty cotton linings; light and dark cords, light and dark cottons (thick); outshots, good, strong, and sound rags; prints, cotton of various grades.

Home linen rags are often mixed with jute and cotton. When jute is present in linen, the colour is not so good when manufactured. The simplest method of discovering the presence of jute in linen is to wash a sample, and treat with diluted chlorine, when the jute will assume a red colour, and the linen bleach white. With cotton in linen, destroy the cotton with sulphuric acid, and only the linen will remain.

Boiling.—Boiling the raw material is most important. Neglect in this department cannot be remedied after the material has left the boilers. It is absolutely necessary to know how to bring the material to the highest state of perfection without injury to its texture, and with a proper regard to the cost. Much depends upon the facilities for boiling, and the quality of the water, whether soft or hard. All rags contain sheive, which nothing but judicious boiling will remove. Badly-boiled stuff consumes too much chlorine, and makes a poor-looking paper. Great waste of chemicals ensues when proper care is not exercised, especially with esparto, one lot boiling with 2 to 3 lb. less caustic soda to the cwt. than others; there is considerable difference in boiling summer and winter esparto: the summer requires more boiling, and turns out better—a fact attributable to the smaller amount of moisture contained in it.

Continental System.—Rags on the Continent are boiled with lime and soda-ash in a very satisfactory and economical manner, as follows:—

No. 1 Stuff.

Lime	216 lb.	for 4000 lb. rags,
Soda-ash (48 %) .	114 „	

boiled for 12 hours with 30 lb. steam pressure in a boiler revolving horizontally.

Nos. 3 and 5 Stuffs.

Lime	324 lb.	for 4000 lb. rags,
Soda-ash (48 %) .	152 „	

boiled as No. 1.

No. 4 Stuff.

Lime	378 lb.	for 4800 lb. rags,
Soda-ash (48 %) .	190 „	

boiled as No. 1.

Ropes for tissue, copying, and cigarette papers.

Lime	648 lb.	for 4000 lb. rope,
Soda-ash (48 %) .	456 „	

boiled for 24 hours as No. 1.

Lime.—Milk of lime is prepared and strained in the following manner:—Construct a wooden box 15 ft. long, 5 ft. wide, and 4 ft. deep, divided into 3 compartments, with false bottoms, perforated with ½-in. holes to retain small stones and sand. In the first compartment the lime is slaked and reduced to a powder; it is then put over into the second, and converted into milk of lime. In the partition between the second and third compartments is a movable sluice, allowing the milk to flow into the third division in regulated quantities. In the third compartment is fitted a revolving drum, like the ordinary drum washer of a half-stuff engine. The milk of lime flowing through the sluice is strained by the revolving drum, on the same principle as that by which the water is lifted from a breaking-engine, and discharged through a pipe direct into the rag boilers. If the lime requires extra straining, a fine wire strainer can be put over the mouth of the pipe leading to the boiler. The compartments are furnished with waste pipes, which, with a liberal supply of water, carry off impurities and what the drum has rejected. This system is satisfactory and cleanly.

Soda-ash.—The preparation of soda-ash is conducted in different ways. Some introduce it into the newly-slaked lime during the heat generated by the slaking; others put the soda-ash direct into the boiler. The latter should never be done; nothing should go into the boiler without straining. The best method is to dissolve the soda-ash separately, and strain through a fine wire strainer into the boiler.

Boiling with Caustic Soda.—Boiling with lime alone is much better and safer for fine-textured materials. The rags turn out better, and it is more economical. The quantities of caustic soda per cwt. of the various qualities of rags are as follows:—

S.P.F.F.F. is boiled with lime alone, then washed in the boiler, and again boiled with 2 per cent. of soda ash.

S.P.F.F. is boiled with 12 lb. of caustic soda (70 %) per cwt.; S.P.F., 14 lb.; fines, 7 lb.; seconds, 6 lb.; L.F.X., 20 lb.; C.L.F.X., 27 lb.; C.C.L.F.X., 30 lb.; F.F., 15 lb.; all boiled with steam at a pressure of 20 to 25 lb. for 10 hours in stationary boilers without vomit, and in boilers revolving horizontally.

Boiling Esparto.—When esparto is insufficiently boiled, and a repetition of the operation is necessary, great waste of soda is caused, and the material does not turn out satisfactorily. The smallest quantity of caustic soda necessary to boil it properly should be ascertained, and that quantity continued until the parcel is finished. The undernoted quantities of caustic soda (70 per cent.) should boil the various espartos in a satisfactory manner:—

Fine Spanish esparto,	28 lb.	per cwt.
Medium " "	24 "	"
Fine Oran	30	
Medium Oran	28	
Fine Susa	28	
Tripoli	32	
Tunis	25	

all boiled for 10 hours in stationary vomiting boilers with 10 lb. steam pressure, taking care that the esparto is sufficiently boiled before the liquor is run off.

Recipes for High-class Papers.—The following recipes will produce papers, smooth, strong, tough, and possessing elasticity of feel and clearness of colour:—

Cream, extra superfine (300 lb. dry paper). S.P.F.F., ¼; dark fines, ¼; green linen, ¼; new pieces, ¼; 4 oz. ultramarine, marked B.B.A.C.; 1½ gill cochineal; 40 lb. pearl hardening.

Cream, superfine (300 lb. dry paper). Dark fines, ¼; S.P.F., ¼; superfines, ¼; Spanish esparto, fine, ¼; 6 oz. ultramarine, B.B.A.C.; 1 gill cochineal; 40 lb. pearl hardening; 14 lb. dry starch.

Creams, fine (300 lb. dry paper). Medium Spanish esparto, ¼; fines, ¼; F.F., ½; 7 oz. ultramarine, marked B.B.R.V.; 1½ gill cochineal.

Commercial post, animal sized, extra superfine (300 lb. dry paper). S.P.F.F.F., ½: dark fines, ¼; new pieces, ¼; 3 gal. engine size; 5 lb. pure alum; 5 oz. ultramarine, B.B.A.C.; 1 pint cochineal; ¼ oz. carmine; 40 lb. pearl hardening.

Commercial post, animal sized, superfine (300 lb. dry paper). S.P.F.F., ½; dark fines, ¼; supers, ¼; 3 gal. engine size; 6 lb. pure alum: 6 oz. ultramarine, B.B.A.C.; 1½ gill cochineal; 1 gill archil; 14 lb. starch; 40 lb. pearl hardening.

Commercial post, animal sized, fine cream (300 lb. dry paper). F.F. Russian rags, ½; seconds, ¼; No. 2 Spanish esparto, ¼; 6 oz. ultramarine, B.B.R.V.; 1 gill magenta; 6 gal. size; 10 lb. alum.

Creams, fourth (300 lb. dry paper). (*a*) Second fines, ¼; F.F., ¼; No. 2 Spanish esparto, ½; 6 pails size; 30 lb. alum; 9 oz. ultramarine, B.B.R.V.; 2 gills archil. (*b*) Fine Oran esparto, ½; Tunis esparto, ¼; F.F. rags, ¼; 9 oz. ultramarine, B.B.R.V.; 2 gills magenta; 4 lb. dry starch.

Drawing cartridge, superior quality, no colouring matter. Cartridge, ½; good canvas, ¼; good seconds, ¼.

Post, extra superfine (300 lb. dry paper). Supers, ¼; green linen, ¼; new pieces, ¼; S.P.F.F.F., ¼; 3 oz. ultramarine, A.C.; 2 oz. carmine. (The highest class of post paper made.)

Blue, extra superfine, high colour (300 lb. dry paper). S.P.F., ¼; dark fines, ¼; fine Spanish esparto, ½; 9½ lb. ultramarine, B.B.R.V.; ½ lb. magenta lake.

Card, superfine, animal sized (300 lb. dry paper). S.P.F., ½; fines, ¼; seconds, ¼; 3 oz. ultramarine, B.B.A.C.; 1 gill archil; 30 lb. pearl hardening.

Drawing cartridge, superfine, animal sized, no colouring matter and no clay. Cartridge, ½; sailcloth without seams, ¼; seconds, ¼. (A superior cartridge.)

Drawing cartridge, second quality, animal sized. F.F., ¼; thirds, ¼; No. 2 Spanish esparto, ½; 4 lb. starch; 20 lb. pearl hardening.

Envelope, superfine cream, animal sized (300 lb. dry paper). S.P.F., ½; seconds, ¼; new pieces, ¼; 3 oz. ultramarine, B.B.A.C.; 1½ pint cochineal; 12 lb. starch.

Blue, superfine high (300 lb. dry paper). S.P.F., ¼; medium Spanish esparto, ½; Scotch fines, ¼; 12 lb. ultramarine marked A; ¾ lb. magenta lake.

Blue, fine high (300 lb. dry paper). F.F., ½; fine Oran esparto, ½; 8 lb. ultramarine, marked B.B.R.V.; ½ lb. magenta lake.

Washing and Breaking.—The rags should be gradually introduced into an engine, previously half filled with water. When the desired quantity (never too thick and difficult to turn) is filled in, go on washing, and let down the roll just sufficient to open up the rags and let the dirt escape, at the same time using the stirring stick above the sand trap, round the sides, and at the back fall of the engine. This prevents "lodgers," or pieces of rag not reduced to half-stuff, hanging about, which, if allowed to escape, would cause knots and grey specks in the paper. The rags must on no account be cut up or forced, but drawn out into fibre without having the smallest particle of rag unreduced to half-stuff; and this can only be accomplished by a liberal use of the stirring-stick and the valve-hook at the back fall of the engine. When the stuff is in condition for emptying into the drainers, the valve should be drawn with care, and deposited on the floor until the engine is empty. Before replacing, the valve must be *carefully* washed, as the hole on the top gets full of dirt and sand, which, when the valve is carelessly drawn, escapes with the stuff. Next lift the sand trap plate, and remove carefully all impurities, replace the plate, and fill up again. If too quickly reduced to half-stuff, the material is weakened, and the washing is insufficiently done; while, if the stuff is properly drawn out into fibre and timed, its texture is not injured, it is better washed, and makes a stronger paper.

Draining and Pressing.—When the stuff is emptied from the washing-engine into the drainers, it immediately commences to drain, and when properly drained for removal, is subjected to pressure. The best method of pressing the water from the stuff is by the extractor (centrifugal drainer), which dries the stuff sufficiently either for gassing or conveying to the poacher, as the case may be. This department ought to be kept scrupulously clean, supplied with a box to contain any stuff that may get dirty, all boxes or waggons periodically washed, and the floor washed once a day.

Astronomical Drawing-paper.—Felix Plateau describes in *Les Mondes* an ingenious process for drawing on paper white lines on a black ground—a method frequently used for astronomical illustrations—by means of which both author and artist are able to judge of the effect of such an illustration before putting it into the hands of the engraver. A piece of thickish paper, as smooth as possible, a little larger than the intended illustration, is heated, by laying it, with proper precautions against being injured, on the top of a stove, and a piece of bees-wax is rubbed over it until the paper is completely covered with a thin coating. A piece of glass, the size of the paper, is blackened by being held over a candle, and, when thoroughly cooled, it is laid on the waxed paper and rubbed thoroughly with the fingers, the result being that a blackened surface is produced on the paper, on which any design can be traced with a needle for the finer lines, or the back of a steel pen for the thicker ones.

Blotting-paper.—This is a paper whose value consists in its absorbing qualities, and these depend as much upon the mode of preparation as upon the material. For blotting of a high class, cotton rags of the weakest and tenderest description procurable should be chosen. Boil them with 4 lb. caustic soda per cwt.—that is, if you have no facilities for boiling them with lime alone. When furnished in the breaking-engine, wash thoroughly before letting down the roll; then reduce them to half-stuff, and as soon as possible empty into the poacher, or convey to the poacher as the case may be, and bleach with great care. When up to the desired colour, empty into the drainer, and drain immediately. It may be mentioned that the breaker-plate ought to be sharp when starting to blottings. The beater roll and plate should be in good order, and the stuff beaten off smartly, not to exceed $1\frac{1}{2}$ hour in the engine. For pink blottings, furnish $\frac{2}{3}$ white cottons and $\frac{1}{3}$ turkey reds, if they can be got; if not, dye with cochineal to the desired shade, empty down to the machine before starting, and see that the vacuum-pumps are in good condition. Remove the weights from the couch roll, and, if there are lifting screws, raise the top couch roll a little. Now take the shake-belt off, as the shake will not be required. Press lightly with the first press, and have the top roll of the second press covered with an ordinary jacket similar to a couch roll jacket. Dry hard, and pass through one calendar with the weights off, and the roll as light as possible — just enough to smooth slightly. (Dunbar.)

Crystalline Paper.—According to Böttger, the simplest method of giving paper surfaces a crystalline coating is as follows:—Mix a very concentrated cold solution of salt with dextrine, and lay the thinnest possible coating of the fluid on the surface to be covered, by means of a broad soft brush. After drying, the surface has a beautiful bright mother-of-pearl coating, which, in consequence of the dextrine, adheres firmly. Prof. Böttger mentions the following salts as adapted to produce the most beautiful crystalline coating:—sulphate of magnesia, acetate of soda, and sulphate of tin. Paper must first be sized, otherwise it will absorb the fluid and prevent the formation of crystals on its surface. Visiting cards with a mother-of-pearl coating have for some time been in use. Coloured glass is well adapted for such a coating, which has a good effect when the light shines through.

Deciphering Burnt Documents.—Rathelot, an officer of the Paris law courts, succeeded in an ingenious manner, in transcribing a number of the registers which were burnt during the Commune. These registers remained so long in the fire that each seemed to have become a homogeneous block, more like a slab of charcoal than anything else, and when an attempt was made to detach a leaf it fell away into powder. Many scientific men examined these unpromising black blocks, when Rathelot hit upon the following method of operation:—In the first place, he cut off the back of the book so as to leave nothing but the mass of leaves which the fire had caused to adhere to each other; he then steeped the book in water, and afterwards exposed it, all wet as it was, to the heat at the mouth of a furnace; the water, as it evaporated, raised the leaves one by one, and they could be separated, but with extraordinary precautions. Each sheet was then deciphered and transcribed. The appearance of the pages was very curious; the writing appeared of a dull black, while the paper was of a lustrous black, something like velvet decorations on a black satin ground, so that the entries were not difficult to read.

Filtering-paper. — That usually

employed is blotting-paper. S. H. Johnson makes a kind by mixing 5 to 20 per cent. of purified animal charcoal powder with the pulp, which is preferably long-fibred.

Hardening Paper.—The French papers speak of a method of rendering paper extremely hard and tenacious, by subjecting the pulp to the action of chloride of zinc. After it has been treated with the chloride, it is submitted to a strong pressure, thereafter becoming as hard as wood and as tough as leather. The hardness varies according to the strength of the metallic solution. The material thus produced can be easily coloured. It may be employed in covering floors with advantage, may replace leather in the manufacture of coarse shoes, and is a good material for whip-handles, the mountings of saws, for buttons, combs, and other articles of various descriptions. An excellent use for it is large sheets of roofing. Paper already manufactured acquires the same consistency when plunged, unsized, into a solution of the chloride.

Iridescent Paper. — Boil 8 oz. nutgalls, 5 oz. iron sulphate, 4 oz. sal-ammoniac, 4 oz. indigo sulphate, 2 dr. gum-arabic, in water, wash the paper with it, and expose to ammonia vapour.

Lithographic Paper.—To prevent ink from adhering to and sinking into lithographic paper, which would render a perfect transfer to the stone impossible, the following plans are used: (1) Coat the paper with three successive layers of sheep-foot jelly, one of cold white starch, and one of gamboge. The first coat is applied by a sponge dipped in the hot solution of jelly, thinly but very evenly over the whole surface; the others are applied in succession, each previous one being allowed to dry first. When the paper is dry, it is smoothed by passing through the lithographic press. (2) Cover rather strong unsized paper with a varnish composed of 120 parts starch, 40 of gum-arabic, and 20 of alum. Make a moderate paste of the starch by boiling, dissolve the gum and alum separately, and then mix all together. When well mixed, apply hot with a flat smooth brush to the leaves of paper. Dry and smooth by passing under the press.

Luminous Paper.—A luminous and damp-proof paper is prepared by adding phosphorescent powder and gelatine to the pulp. The proportions are: 10 parts water, 40 paper pulp, 20 phosphorescent powder (preferably slacked for 24 hours), 1 gelatine, 1 saturated solution potash bichromate. See also Luminous Substances, p. 380.

Oiled Paper.—(1) Brush sheets of paper over with boiled oil in which a little shellac has been carefully dissolved over a slow fire; suspend on a line till dry. (2) The paper is laid on a square board, and well covered with a mixture composed as follows: boiled linseed-oil is reboiled with litharge, lead acetate, zinc sulphate, and burnt umber, 1 oz. of each per gal. The first sheet is covered on both sides, the second, placed on this, receives one coating, and so on; separate, and hang up to dry.

Packing-paper. — (1) Packing-paper may be made water-tight by dissolving 1·82 lb. of white soap in 1 qt. water, and dissolving in another qt. 1·82 oz. (apothecaries' weight) gum-arabic, and 5·5 oz. glue. The two solutions are mixed and warmed, the paper is soaked in the mixture, and passed between rollers or hung up to dry. (2) The paper is treated with boiled linseed-oil, the excess of oily particles being removed by benzene; it is then washed in a chlorine bath, and, after drying, treated with hydrogen peroxide. If the paper has been made from ropes, it is coated with a layer of starch before the treatment with linseed-oil and benzene. The final operation is "satining," by a passage through smooth rollers. (3) Russian oil-cask bottoms are often pasted over on the outside with a kind of paper having a gelatinous-looking skin, and which is quite oil-tight. Such has been brushed over with a mixture of blood and lime, a preparation much used in Russia and China, and quite oil- and water-tight. Chinese packing-cases are often pasted over with paper painted with this mixture. The Chinese *schio-liao* (see p. 72) is made by mixing 3 parts fresh blood (beaten up till free from fibrine) with 4 of dry powdery slaked lime and a little alum. The thin pasty mass thus obtained may be used at once.

Safety-paper.—Paper which has been passed through a solution of glue with 5 per cent. potassium cyanate and antimony sulphide is immersed in a dilute solution of magnesium or copper sulphate, and afterwards dried. Nothing written on this paper with ink prepared from galls and iron salts can be destroyed by acids, &c., nor by mechanical erasing. Acids would colour the black writing blue or red, while alkalies would colour the paper brown; erasing would remove the surface of the paper, and show the white ground.

Smoothing Paper. — Lay the paper, face downwards, on a sheet of smooth unsized white paper; cover it with another sheet of the same, very slightly damped, and iron with a moderately warm flat-iron.

Splitting a Sheet of Paper.—People who have not seen this done might think it impossible; yet it is not only possible, but extremely easy. Get a piece of plate-glass, and place on it a sheet of paper; then let the latter be thoroughly soaked. With care and a little dexterity, the sheet can be split by the top surface being removed. But the best plan is to paste a piece of cloth or very strong paper to each side of the sheet to be split. When dry, violently and without hesitation pull the two pieces asunder, when part of the sheet will be found to have adhered to one and part to the other. Soften the paste in water, and the pieces can be easily removed from the cloth. The process can be utilized in various ways. If it be wanted to paste in a scrap-book a newspaper article printed on both sides of the paper, and there is only one copy, it is very convenient to know how to detach the one side from the other. The paper when split, as may be imagined, is more transparent than before, and the printing-ink is somewhat duller.

Test-papers. —*Litmus.*—To prepare litmus-paper, rub good litmus with a little hot water in a mortar, and pour the mixture into an evaporating basin; add water until the proportion is ½ pint water to 1 oz. litmus; cover up so as to keep warm for an hour, after which the liquid must be filtered, and fresh hot water poured on the residue. This is boiled, covered up as before, and allowed to stand. The operation is repeated a second time, and if much colour comes, a third time. The first solution is kept separate from the second and third, which may be mixed together. The first will not require evaporation, but the others may be so far reduced in quantity that when a piece of blotting- or filtering-paper is dipped into them and dried, they will impart to it a blue colour of sufficient intensity for use. The paper is then dipped in the solution. The paper—blotting will suit very well—should always be unsized, of good colour, and moderate thickness, say 15 to 20 lb. demy, and cut into pieces of a convenient size for dipping. Particular care should be taken to use paper as free as possible from earthy matter, and especially from carbonate of lime. Sized papers produce a finer tint on the surface, but are not so delicate as a test. Pour the litmus solution into a plate, and draw the slips of paper through it in such a manner that the fluid will come into contact with both sides; allow it to drip, then hang them across two thread lines to dry. The tint ought to be a distinct blue, and may be tested as to its delicacy by touching the paper with a very dilute acid, observing whether the red colour produced is vivid or not. It should, when dry, be tied up into bundles, and preserved from the air and light. A wide-necked glass-stoppered bottle is best suited for the purpose. Put in the test-papers, and paste round the sides of the bottle a piece of dark paper to exclude the light, as both air and light tend to destroy the colour and efficacy of the test-paper.

Turmeric.—This is prepared in a

manner similar to litmus-paper. A hot infusion of finely-crushed turmeric is made by boiling 1 oz. turmeric in 12 oz. water for ½ hour; strain through a fine cloth or silk bag, and leave the fluid to settle for a few minutes. The liquid should be of such strength that paper dipped into it and then dried will have a fine yellow colour. The paper should be of the same quality in every respect as for litmus-paper. No particular care is necessary in drying, as with litmus-paper; but both papers should be prepared where acid and alkaline fumes cannot come into contact with them, as they injure the colour of both.

Tracing-paper. — (1) A German invention has for its object the rendering more or less transparent of paper used for writing or drawing, either with ink, pencil, or crayon, and also to give the paper such a surface that such writing or drawing may be completely removed by washing, without in any way injuring the paper. The object of making the paper translucent is that when used in schools the scholars can trace the copy, and thus become proficient in the formation of letters without the explanations usually necessary; and it may also be used in any place where tracings may be required, as by laying the paper over the object to be copied it can be plainly seen. Writing-paper is used by preference, its preparation consisting in first saturating it with benzine, and then immediately coating the paper with a suitable rapidly-drying varnish before the benzine can evaporate. The application of varnish is by preference made by plunging the paper into a bath of it, but it may be applied with a brush or sponge. The varnish is prepared of the following ingredients:—Boiled bleached linseed-oil, 20 lb.; lead shavings, 1 lb.; oxide of zinc, 5 lb.; Venetian turpentine, ½ lb. Mix and boil 8 hours. After cooling, strain, and add 5 lb. white copal and ½ lb. sandarach. (2) The following is a capital method of preparing tracing-paper for architectural or engineering tracings:—Take common tissue or cap-paper, any size of sheet; lay each sheet on a flat surface, and sponge over (one side) with the following, taking care not to miss any part of the surface:—Canada balsam, 2 pints; spirits of turpentine, 3 pints; to which add a few drops of old nut-oil; a sponge is the best instrument for applying the mixture, which should be used warm. As each sheet is prepared, it should be hung up to dry over two cords stretched tightly and parallel, about 8 in. apart, to prevent the lower edges of the paper from coming in contact. As soon as dry, the sheets should be carefully rolled on straight and smooth wooden rollers covered with paper, about 2 in. in diameter. The sheets will be dry when no stickiness can be felt. A little practice will enable anyone to make good tracing-paper in this way at a moderate rate. The composition gives substance to the tissue-paper. (3) You may make paper sufficiently transparent for tracing by saturating it with spirits of turpentine or benzoline. As long as the paper continues to be moistened with either of these, you can carry on your tracing; when the spirit has evaporated, the paper will be opaque. Ink or water-colours may be used on the surface without running. (4) A convenient method for rendering ordinary drawing-paper transparent for the purpose of making tracings, and of removing its transparency, so as to restore its former appearance when the drawing is completed, has been invented by Puscher. It consists in dissolving a given quantity of castor-oil in one, two, or three volumes of absolute alcohol, according to the thickness of the paper, and applying it by means of a sponge. The alcohol evaporates in a few minutes, and the tracing-paper is dry and ready for immediate use. The drawing or tracing can be made either with lead-pencil or Indian ink, and the oil removed from the paper by immersing it in absolute alcohol, thus restoring its original opacity. The alcohol employed in removing the oil is, of course, preserved for diluting the oil used in preparing the next sheet. (5) Put ¼ oz. gum-mastic into a bottle holding 6 oz. best spirits of turpentine, shaking it up day by day; when thoroughly dissolved, it is ready for use. It can be made thinner at any time by adding more turps. Then take some sheets of the best quality tissue-paper, open them, and apply the mixture with a broad brush. Hang up to dry. (6) Carbon tracing-paper is prepared by rubbing into a suitable tissue a mixture of 6 parts lard, 1 of beeswax, and sufficient fine lampblack to give it a good colour. The mixture should be warm, and not be applied in excess. (7) Saturate ordinary writing paper with petroleum, and wipe the surface dry. (8) Lay a sheet of fine white wove tissue-paper on a clean board, brush it softly on both sides with a solution of beeswax in spirits of turpentine (say about $\frac{1}{2}$ oz. in $\frac{1}{2}$ pint), and hang to dry for a few days out of the dust.

Transfer-paper.—Rub the surface of thin post or tissue paper with graphite (black-lead), vermilion, red chalk, or other pigment, and carefully remove the excess of colouring matter by rubbing with a clean rag.

Waxed Paper.—Place cartridge or other paper on a hot iron and rub it with beeswax, or brush on a solution of wax in turpentine. On a large scale, it is prepared by opening a quire of paper flat upon a table, and rapidly ironing it with a very hot iron, against which is held a piece of wax, which, melting, runs down upon the paper and is absorbed by it. Any excess on the topmost layer readily penetrates to the lower ones. Such paper is useful for making waterproof and airproof tubes, and for general wrapping purposes.

PARCHMENT.—*Natural.*—(1) In making natural parchment, the pelts, after liming, washing, and fleshing, as for leather-dressing, are split by the splitting-machine, and the inner layer is taken for making parchment. Knots are made in the edges of this layer by tying up portions of lime or rubbish into balls all round, and by these knots the skin is stretched upon wooden frames. Whilst on the frames, the split side is scraped to render it even, and the skin is then "dubbed" with whiting and a strong solution of soda-ash to get out the grease. Next it undergoes a series of scaldings with hot water thrown upon it out of a bowl, of scrapings, and of washings with whiting and water, and is finally dried in a warm chamber. (Ballard.)

(2) To make parchment transparent, soak a thin skin of it in a strong lye of wood-ashes, often wringing it out till it becomes transparent; then strain it on a frame and let it dry. This will be much improved if, after it is dry, it receives a coat on both sides of clear mastic varnish, diluted with spirits of turpentine.

Artificial.—(1) Strong unsized paper is immersed for a few seconds in oil of vitriol (concentrated commercial sulphuric acid), diluted with half its volume of water. It is then washed in pure water or weak ammonia water. It strongly resembles animal parchment, and is used for the same purposes. The acid solution must be exactly of the strength indicated, and not warmer than the surrounding atmosphere.

(2) Another method consists in using the commercial oil of vitriol in an undiluted state. The paper is first passed through a solution of alum and thoroughly dried previous to its immersion, thus preventing any undue action of the corrosive principle of the vitriol. After the application of the acid, the paper is passed into a vat of water, and then through an alkaline bath, to be again washed. Written and printed paper may undergo this process without materially affecting the clearness and distinctness of the letters, and the paper retains all its qualities, even after being wetted several times in succession; while paper prepared in the usual manner loses, to a great extent, its pliancy, and becomes hard and stiff.

(3) By immersing cellulose for a few seconds in a perfectly cold mixture of 2 parts oil of vitriol and 1 of water, although no alteration of its chemical constituents takes place—except perhaps a purely molecular one—its physical characteristics are greatly changed, it being converted into a leather-like body of great comparative

toughness. White unsized paper—itself a tolerably pure form of cellulose—thus treated, goes by the name of "parchment paper," and its tensile strength is increased to some 40 or 45 times that of the original paper used. This form of cellulose is especially well adapted for many purposes in medicine and pharmacy, including "caps" for jars and bottles, sample envelopes, labels, "untearable tallies," and even certain forms of surgical bandages. By treating "parchment" or "Gaine's" paper—as it is sometimes called from the name of its inventor—with a little hot strong solution of gelatine, to which about 2½ or 3 per cent. of glycerine has been added, and allowing it to dry, it may be rendered tolerably impervious to fatty matters, so that it then forms a convenient medium in which to pack small quantities of such substances as ordinarily are apt to soil the paper they are wrapped in. The same altered variety of cellulose, if soaked with benzol or carbon bisulphide holding 1 per cent. of linseed-oil and 4 of indiarubber in solution, makes, when dry, an admirable and inexpensive waterproof envelope for the preservation and transport of drugs and deliquescent salts. By using an envelope of this description, closing it carefully (when filled) with a little stronger solution of caoutchouc, and afterwards placing the same inside a similar one of large size containing fine oven-dried oatmeal, even calcium chloride and crystals of ammonium nitrate have been forwarded in damp weather without their having attracted moisture or suffered any appreciable change during transit. (*Monthl. Mag.*)

Removing wrinkles.—When parchment documents are wrinkled and creased, the evil may be remedied, without injury to the writing, in the following manner:—Place the document, face downward, upon a clean piece of blotting-paper. Beat up to a clear froth, with a few drops of clove-oil, the whites of several fresh eggs, and with the fingers spread this over the back of the sheet, and rub it in until the parchment becomes uniformly soft and yielding. Then spread it out as smoothly as possible, cover it with a piece of oiled silk, put on it a piece of smooth board, and set it aside in a cool place, with a weight on the board, for 24 hours. Then remove the board and silk, cover with a piece of fine linen cloth, and press with a hot smoothing-iron (not too hot) until all signs of wrinkles have disappeared. The heat renders the albumen insoluble, and not liable to change.

PERCHLORIC ACID.—It is recommended that this acid should be prepared by the user himself, the cost in this case being 7*s.* to 9*s.* a lb., whereas the manufacturers demand 40*s.* It can be prepared in the following manner without the slightest danger:—Pure barium chlorate is dissolved in lukewarm water, and dilute sulphuric acid is added. The precipitate is allowed to settle, the clear liquid is poured off, and the barium sulphate is thoroughly washed. The chloric acid solution is then evaporated over a fire until the concentrated solution becomes yellow, and on further evaporation produces a peculiar noise. The liquid is divided into two parts, placed in two dishes 6 in. wide, and containing about 175 fl. dr., and evaporated further until the liquid is quite decolorized and thick white fumes are given off. In order to lessen this unavoidable loss of perchloric acid, the liquid can be diluted from time to time with a little water. The colourless liquid is then distilled in a retort heated on a sand-bath, and collected in a long-necked receiver. The perchloric acid so obtained contains traces of iron. (*Monit. Scient.*)

PIGMENTS, PAINT, AND PAINTING. — These three heads form but one subject, and are appropriately discussed together, in their natural order, which is—(1) Pigments, the preparation of the dry colouring matters; (2) Paint, the compounding of these colouring matters with driers and vehicles ready for application; (3) Painting, the application of the prepared paint to various surfaces.

Pigments.—The term "pigments" is applied to colouring matters which are mixed in a powdery form with oil or other vehicle for the purposes of painting. They differ in this respect from dyestuffs. A very large proportion of the pigments are derived from the mineral kingdom. Organic colouring matters for use as pigments are mostly made in the form of "lakes," by one of the three following methods:—(*a*) To a filtered solution of the colouring matter is added a solution of alum; the whole is agitated, and the colour is precipitated by a solution of carbonate of potash. (*b*) A solution of the colouring matter is made in a weak alkaline lye, and precipitated by adding a solution of alum. (*c*) Recently-precipitated alumina is agitated with a solution of the colouring matter as before, until the liquid is nearly decolorized, or the alumina assumes a sufficiently deep tint. The first method is generally adopted for acidulous solutions of colouring matter, or those injured by alkalies; the second, for those not injured by alkalies; the third, for those whose affinity for gelatinous alumina enables them to combine with it by mere agitation.

Alumina in a state suitable for the preparation of "lakes" may be produced in the following manner:—Dissolve 1 lb. alum in ½ gal. water, and add 75 gr. copper sulphate and about ¼ lb. zinc turnings; leave the mixture for 3 days in a warm place, renewing the water lost by evaporation. The copper is first deposited upon the zinc, the two metals thus forming a voltaic couple. Hydrogen is disengaged, zinc sulphate is formed, and the alumina gradually separates in the state of very fine powder; the action is allowed to continue till no more alumina is left in solution, or until ammonia ceases to give a precipitate. If the reaction is prolonged beyond this point, iron oxide will precipitate if present. The alumina washes easily, and does not contract upon drying. (*Dern. Prog. de l'Ind. Chim.*)

It will be convenient to describe the various pigments under the heads of the chief colours in alphabetical order—blacks, blues, greens, reds, whites, and yellows.

BLACKS. — The most important of these are animal-black, bone-black, Frankfort-black, ivory-black, lamp-black, and soot-black. They are mostly obtained by carbonizing organic matter in closed vessels or crucibles, or by collecting the soot formed by the combustion of oily, resinous, and bituminous substances.

Animal-black.—This is almost identical with bone-black, but is generally in a more finely-divided state. Any refuse animal matter may be used in its preparation, such as albumen, gelatine, horn shavings, &c. These are subjected to dry distillation in an earthenware retort. An inflammable gas is given off, together with much oily matter, ammonia, and water, while a black carbonaceous mass is left behind. This is washed with water and powdered in a mill, the product being animal-black. It is largely used in the manufacture of printing-ink and blacking.

Bone-black.—When bones are heated in a crucible, the organic constituents are decomposed and carbonized. A mixture of combustible gases is given off, which do not condense on cooling; and others, which condense in the form of a heavy oil called bone-oil, and also much water containing tarry water and ammoniacal salts in solution. The residue consists of finely-divided carbon in intimate mixture with the inorganic constituents of the bones: this mixture constitutes ordinary bone-black. The inorganic portion may be removed by washing the residue in dilute hydrochloric acid.

The process, as worked on the large scale, is carried on in different ways, according as it is desired to collect the volatile condensable portion of the distillate, or to allow it to escape. When it is required to obtain only bone-black, the apparatus employed is simple, and the amount of fuel needed is comparatively small. Carbonization is effected in fireclay crucibles, 16 in. high and 12 in. in diameter. These are preferred to iron crucibles, which were much used at one time, since they do not lose their round form when subjected to a high temperature; in consequence of this they fit closely together in the furnace, less air can penetrate, and therefore less charcoal is consumed by oxidation. The furnace is an ordinary flat hearth, having a superficial area of about 40 sq. yd., and is covered in with a flat arch, all of brickwork. The fireplace is situate in the middle of the hearth; the crucibles are introduced through doors in the front, which are bricked up when the furnace is filled; each furnace holds 18 crucibles. The crucibles, filled with the coarsely-broken bones, are covered with a lid luted on with clay. To economize fuel, the furnaces should be in a row, and placed back to back.

When the furnace is filled and the doors are bricked up, the heat is slowly raised to redness, at which point it is kept for 6 or 8 hours. The combustible gases are evolved and consumed in the furnace as soon as the bones begin to decompose, and by this means so much heat is produced that only a small quantity of fuel is needed to maintain the required temperature. When the carbonization is complete, the doors are taken down and the crucibles removed to cool, their place being immediately filled with fresh ones. The heat must be kept uniform throughout: if it be not sufficiently high, the bone-black will contain a portion of undecomposed organic matter, which renders it quite unfit for use; if it be raised too high, the bone-black will become dense and compact, whereby its efficacy as a decolorizer is much reduced. When the charcoal in the crucible has become perfectly cool, it is removed and crushed. When required for decolorizing or deodorizing purposes, it is only roughly broken up into small lumps, in which form it is most readily applicable. The crushing is effected by means of two grooved cylinders, consisting of toothed discs, alternately 10 and 12 in. in diameter. These are so placed that the 10-in. discs of one cylinder are opposite the 12-in. discs of the other, and thus, in revolving, the carbonized bones are crushed to fragments between them, but are not reduced to powder. They are passed successively through 6 of these mills, the cylinders of each couple being nearer to each other than the last. Finally, the crushed bones are carefully sifted; the powder is placed apart from the lumps, again passed through finer sieves, and sorted out into different sizes. A furnace such as that described will carbonize 4 charges of bones in one day, each charge being more than ½ ton in weight. With careful work, the bones will yield 60 per cent. of bone-black, or more than 1 ton daily.

If it be required to condense the volatile gaseous products of the carbonization, this process is conducted in retorts similar to those used in the manufacture of acetic acid from wood. The aqueous portion of the distillate is usually evaporated down to obtain salts of ammonia; the uncondensable gases may be employed for illuminating purposes. The manufacture of bone-black is usually carried on in the neighbourhood of large towns, where a good supply of bones may be readily obtained. Its principal use is to decolorize various solutions; inferior qualities are used as pigments.

Ordinary bone-black has about the following composition:—Phosphate and carbonate of lime, and sulphide or oxide of iron, 88 parts; charcoal, containing a small quantity of nitrogenous matter, 10 parts; silicated carbide of iron, 2 parts. The decolorizing properties of bone-black are due solely to the presence of the charcoal.

Frankfort-black.—Frankfort-black is a powder obtained from dried vine-twigs, carbonized to a full black, and then ground very fine. On a large scale, it is prepared from a mixture of vine-twigs, wine-lees, peach-stones, bone-shavings, and ivory refuse. It varies in shade according as animal or vegetable charcoal is in excess; when the latter predominates, the powder is of a bluish colour; when the former, it has a brownish tinge. It is customary to wash the powder well when first made, in order to remove any soluble inorganic impurities. It makes an excellent pigment, and is extensively used by copperplate engravers in the preparation of their ink.

Ivory-black.—Ivory-black is a beautiful pigment prepared by carbonizing waste fragments and turnings of ivory. These are exposed to a red heat for some hours in crucibles, great care being taken to avoid overheating or burning. When quite cold, the crucibles are opened, and the contents pulverized, the richest coloured fragments being kept apart for the best quality. The powder is then levigated on a porphyry slab, washed well with hot water on a filter, and dried in an oven. The product is of a very beautiful velvety black colour, superior even to that obtained from peach kernels, and quite free from the reddish tinge which so often characterizes bone-black. Ivory-black is employed by copperplate printers in the preparation of their ink. Mixed with white-lead, it affords a rich pearl-grey pigment.

Lamp-black.—Lampblack is an exceedingly light, dull-black powder, formed by the imperfect combustion of oils, fats, resins, &c. It may be prepared on a small scale by suspending a small tinplate funnel over the flame of a lamp fed with oil, tallow, or crude naphtha, the wick being so arranged that it shall burn with a large and smoky flame. Dense masses of this light carbonaceous matter gradually collect in the funnel, and may be removed from time to time. The funnel should be furnished with a metallic tube to convey the gases away from the room, but no solder must be used in making the connections. An especially fine quality of lampblack is obtained from bone-oil deprived of the ammonia with which it is always contaminated.

A process has been devised by Martin and Grafton for the preparation of lampblack from coal-tar, which affords a very good product. The coal-tar is first stirred up energetically with lime-water, and the mixture is allowed to stand until the coal-tar has subsided to the bottom, when the lime-water is drawn off. The tar is then well washed by decantation with hot water, and rectified in the ordinary naphtha still. Afterwards it is run into a long iron cylinder, which is placed over a furnace, and supplied with numerous large burners. Each burner has a metallic funnel placed immediately above it, connected with a cast-iron pipe, into which all the fumes from each burner are conducted. The naphtha in the cylinder is heated almost to the boiling-point by the furnace beneath. A series of smaller pipes lead away the fumes from the main pipe into a row of chambers, and thence into a series of large canvas bags, placed side by side, and connected alternately at top and bottom. The bags vary in number from 50 to 80, the last one being left open to allow the smoke to escape, after traversing some 400 yd. since leaving the burners. The best quality of lampblack is found in the last bags, that near the furnace being much coarser and less pure. The bags are emptied whenever they contain a sufficient quantity.

The process employed in Germany for the manufacture of lampblack is to conduct the products of the combustion of any resinous matter in a furnace into a long flue, at the end of which is placed a loose hood, made of some woollen material, and suspended by a rope and pulley. The lampblack collects in this hood, and, when a sufficient quantity has accumulated, is shaken down and removed. In this manner about 6 cwt. of lampblack may be collected in 24 hours.

In England, an inferior variety is sometimes obtained from the flues of coke-ovens. That known as "Russian lampblack" is made by burning chips of resinous deal or pine-wood, and collecting the soot formed; but it is objectionable, owing to its liability to take fire spontaneously when left for a long time moistened with oil.

The lampblack made in these ways is generally purified by calcination, in order to remove the empyreumatic oils which it invariably contains. This is effected in close vessels, and the product is called "burnt" lampblack, and is especially useful as a water-colour. The particular virtue of lampblack as a pigment lies in its state of extremely fine division, which could not possibly be attained by other means; this quality renders it invaluable as the basis of black pigments, all of which contain it in a greater or less quantity. Indian ink and printers' ink are also composed principally of this substance.

At Petrolia the flames of several thousand natural gas-jets are made to impinge against sheets of slate, on which the smoke or fine carbon is deposited, just as a piece of glass is smoked when held over a candle flame. When a sufficient deposit of the smoke has formed on the slates, it is scraped off, packed, and sent to market. This product proves to be of a perfectly black tint, and to contain no oily matter, while on combustion it leaves only a slight trace of ash, composed of the oxides of iron and copper.

The transport of lampblack is effected in barrels or bags; when in the latter, these should be previously soaked in water containing some clay in suspension, which stops up the pores of the sacking, and prevents loss.

Sight-black. —(1) Camphor smoke makes an excellent black, but has the disadvantage of coming off with the least touch or drop of rain. (2) A good and tolerably permanent black is made of 1 part stick lac, 1 of lampblack, and 6 of methylated spirit.

Soot-black.—A very cheap and good black is made by calcining soot. The process has been already described on p. 102.

BLUES.—*Antimony-blue.*—Kraus prepares a fine blue, rivalling ultramarine, and capable of giving beautiful green shades (equal to Schweinfurth green, and without its arsenical character) when mixed with chrome yellow or with zinc chromate, by adding a solution of yellow (ferro-) cyanide of potassium to one of antimony in aqua regia, and filtering through ground glass, as long as a precipitate forms. This precipitate contains no antimony, the antimony salt simply facilitating the formation of the pigment; mercury salts will also give it. The blue is soluble in hydrochloric acid, which successively renders it green and yellow; on standing, the blue colour is restored. Alkalies immediately decompose it. In fact it is merely a variety of Prussian blue. (*Dingler's Pol. Jl.*)

Antwerp-blue.—This is a mixture of Prussian blue, alumina, magnesia, and zinc oxide, in various proportions. It is prepared like Prussian blue, except that the zinc, magnesia, and alum are added to the lye of crude potassium ferrocyanide.

Cobalt- or Thénard-blue.—This might replace ultramarine, but for its defect of having a violet hue by artificial light. Its full intensity of colour is only developed after long exposure to the air, when it acquires a slightly green tint. The mode of preparing it is as follows:—Roasted cobalt ore is heated with excess of dilute nitric acid, and the solution is evaporated nearly to dryness in a porcelain vessel. The residue is boiled with water, and filtered, in order to remove the precipitated arseniate. Into the filtrate is poured a solution of basic phosphate of soda, which produces a precipitate of basic phosphate of cobalt. This is washed and collected on a filter. While still gelatinous, 1 part of it is thoroughly mixed with 8 parts hydrated alumina, recently precipitated from a solution of potash-alum by ammonia. The mixture is dried to brittleness, and calcined at a cherry-red heat for ½ hour in a covered clay crucible. The resulting pigment is kept in glass jars. It is essential that the alumina be prepared with sufficient excess of ammonia, and washed several times with very clear water. Arseniate of cobalt may replace the phosphate, in which case, only half the quantity of the cobalt salt is needed. It is asserted by Boullai-Marillac that by substituting lime for the alumina a richer and more velvety blue is produced.

Cæruleum-blue.—This blue, for oil- and water-colour painting, is introduced by Rowney and Co. It is entirely soluble in hot hydrochloric acid, and the light-blue tint of the solution becomes violet-red on diluting with water. The original colour reappears by concentration, and the pigment is restored if the solution be evaporated to dryness. Nitric acid dissolves the cobalt and leaves a white residue, mostly composed of stannic acid. The green colour shows the presence of small proportions of iron and nickel. Concentrated sulphuric acid does not dissolve it, but, diluted with 4 volumes of water, produces partial decomposition. Acetic acid and caustic potash do not act upon it. Cœruleum is principally a combination of a tin oxide with cobalt oxide. Berzelius mentions a stannate of cobalt, prepared by adding a solution of potash stannate to one of cobalt. The bluish precipitate formed becomes light-red after washing, and then brown. Calcined at white heat, its colour changes to a light blue. The composition of cœruleum is—

Oxide of tin (stannic acid)	49·66
Oxide of cobalt . . .	18·66
Sulphate of lime and silica	31·68
(Riffault.)	100·00

Egyptian-blue. — A very beautiful shade of blue is noticeable upon many ancient monuments found in the tombs of Egypt. Analysis proves the colour to be formed by a combination of soda, sand, and lime, with certain proportions of copper, from which substances the Egyptians prepared 3 different products:—(1) A peculiar red, green, and blue glass; (2) a brilliant enamel; (3) the colour to which reference is made, and which was used for painting. Péligot has succeeded in reproducing this shade of blue by heating together 73 parts silica with 16 oxide of copper, 8 lime, and 3 soda. If the temperature exceed 800° F. (426½° C.), a valueless black product results.

Manganate-blue.—In preparing calcium chloride by calcining a mixture of chalk and chlorine residues, Kuhlmann found in the furnaces a slag of bright blue colour, consisting of manganate of lime. It resembles ultramarine, but, though not soluble in water, is not durable when in contact with it.

Paris- or Turnbull's-blue. — (*a*) A thorough mixture of 2 parts sulphur and 1 dry soda carbonate is gradually heated in a covered crucible to redness or till fused; a mixture of soda silicate and aluminate is sprinkled in, and the heat is continued for an hour; the little free sulphur present may be washed out by water. (*b*) An intimate mixture of 37 parts China-clay, 15 soda sulphate, 22 soda carbonate, 18 sulphur, and 8 charcoal, is heated in large crucibles for 24 to 30 hours; the mass is re-heated in cast-iron boxes at a moderate temperature till the desired tint appears, and is finally pulverized, washed, and dried. (*c*) Gently fuse 1075 oz. crystallized soda carbonate in its water of crystallization; shake in 5 oz. finely-pulverized orpiment, and, when partly decomposed, as much gelatinous alumina hydrate as contains 7 oz. anhydrous alumina; add 100 oz. finely-sifted clay, and 221 oz. flowers of sulphur; place the whole in a covered crucible, and heat gently till the water is driven off, then to redness, so that the ingredients sinter together without fusing; the mass is cooled, finely pulverized, suspended in river-water, and filtered. The product is heated in a covered dish to dull redness for 1 to 2 hours, with occasional stirring. Colourless or brownish patches may occur, and must be removed.

Péligot-blue. — This is a hydrated oxide of copper, which resists boiling water and a heat of 212° F. (100° C.). It is prepared from any soluble salt of copper, but preferably the sulphate, a dilute solution of which is treated with excess of ammonia and precipitated by potash or soda.

Prussian-blue. — The average composition of Prussian-blue is 3 equivalents iron protocyanide, 2 sesquicyanide, and 9 water. The proportions of the cyanides are liable to differ, and this fact, combined with varying quality of the raw materials and mode of preparation, renders the colouring intensity subject to fluctuation. According to the most general mode of preparation, a solution of alum and iron sulphate in water is mixed with one of yellow prussiate of potash (*potassium ferrocyanide*).

Prussiate of potash is made by heating together crude potash carbonate and refuse animal matters, such as "*flocks*" (the waste or refuse woollen dust from wool-mills), clippings of leather, horn, hoof, &c. The process is conducted in a closed building with louvre openings in or along the roof. Iron pots 2 to 3 ft. wide and deep are used, arranged in a bank, and heated by fires underneath. There are always more pots than are in use at any one time, since they wear out after a few weeks, the material of the pot furnishing the iron necessary for the formation of the salt. Each pot is furnished with a flat-iron cover, capable of partial removal for introduction of material; also with a stirrer inside, the vertical shaft of which passes through the cover, and is set in motion by a shaft passing along above the series of pots. The potash being put in, the animal material is added in shovelfuls from time to time, the removable portion of the cover being raised for the purpose; the heating operation is continued for 3 or 4 hours, and then the contents of the pot are taken out and thrown into a tank of cold water, which dissolves out the *prussiate*. A carbonaceous matter remains, and is usually sent away to sewage or manure works to be used as a deodorizer. The further processes consist in recrystallization of the salt upon strings suspended in the crystallizing tank.

During the heating process, flame and offensive smoke issue from the gaps about the covers of the pots, and directly from the pots themselves when the cover is raised to put in fresh material. This smoke is often a source of nuisance. The best mode of preventing it is in operation at Sir E. Buckley's works, Edge Lane, Clayton, near Manchester. The arrangements which have been most effectual in obviating nuisance were devised by Prof. Roscoe, and are represented in Fig. 15. From the back part of the lid of each pot A, a pipe c passes, first upwards, then horizontally, and downwards to the back part of the flue *d*, which surrounds and heats the pot. The pipe is hinged to allow of the lid *a*, with the part of the pipe connected with it, being raised. The smoke and fumes are drawn down to the flue, where they meet the flame of the fire and are consumed, the products of combustion being carried off by a tall chimney. The building, in which 21 pots are arranged along one side, is 50 yd. long by 11 yd. wide and high. It is lit all along the top of the roof by skylights, below which are louvres, and is ventilated by openings in the side and end walls: *b* is the stirrer, which makes 24 revolutions per minute. (Dr. Ballard.)

For making Prussian-blue, the solution of (yellow) prussiate of potash is poured by degrees into a hot solution of pure iron sulphate and alum. The proportions are varied according to the quality desired. The common relative quantities are 1 part alum to 7 or 8 of iron sulphate; for inferior grades, these are reduced to 1 alum and 2 or 3 iron sulphate, or even to equal parts of each.

Each addition of cyanide lye to the iron solution produces abundant hydrosulphuric and carbonic acids, whose escape is aided by stirring the liquor with a wooden rod. The precipitate is brownish-green, and is washed with pure water until it turns entirely blue. After settling and decanting the liquors, the blue precipitate is placed upon a cloth filter, and washed with water holding a little sulphuric acid. The drained blue is pressed in boxes, to remove the greater part of its water, and the thick resulting paste is divided into rectangular blocks, which are dried in the dark, or in a stove-room not above 77° to 86° F. (25° to 30° C.).

Prussian-blue is next in purity of tone after ultramarine and cobalt, and though inferior in durability, contains more colouring power—10 or 11 times; but all alkalies alter it. Large quantities are used by house-painters and decorators, and by manufacturers of paper-hangings. Of all blues it is the most intense. Mixed with white lead, the hue is slightly greenish. A mixture of 1 gr. Prussian-blue and 90 white produces sky-blue; 200 white and 1 blue give azure-white. To judge of the beauty of a Prussian-blue, it should be incorporated with 50 to 100 times its weight of fine white-lead. Mixed with 15 to 20 times its weight of chrome-yellow, it produces handsome greens, not very lasting, however. It is employed with glue, size, or oil; in the latter case, it should not be kept long, or it becomes thick, and does not flow well under the brush. The pure blue ground in oil produces velvety blacks. Old damp walls destroy the colour of Prussian blue by the nitrate of lime they contain, producing, by double decomposition, a ferrocyanide of calcium and a nitrate of iron. (Riffault.)

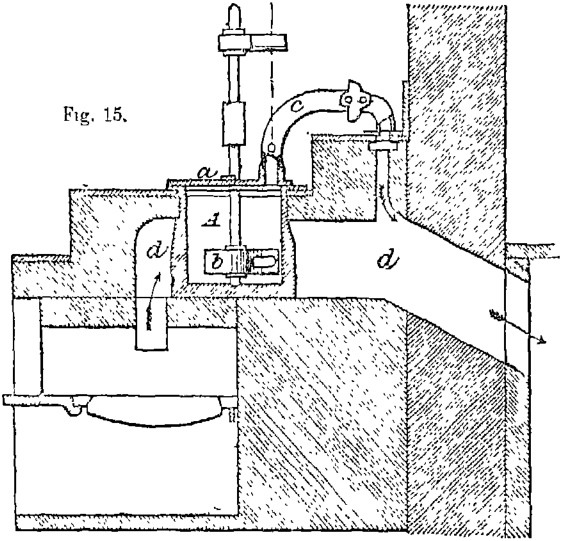


Fig. 15.

This colour may be made in small quantities in the following manners:—(*a*) Dissolve 1 oz. iron sulphate and 8 oz. alum in 1 gal. water; add separate solutions of prussiate (yellow) of potash and pearlash until the precipitation ceases; collect the precipitate after some time, wash thoroughly, and dry. (*b*) Mix a solution of iron protosulphate with one of red prussiate of potash (ferricyanide); wash, and dry.

Smalt- or Saxony-blue.—This appears to be a double silicate of potash and cobalt, mixed with lime, alumina, magnesia, iron oxide, nickel oxide, arsenic, carbonic acid, and water. The intensity of the colour, in Ludwig's opinion, depends on the greater or less proportion of the double silicate. The materials employed in the manufacture are cobalt ore, sand, and potash. The mineral generally used in Saxony is a *speiss*, or arsenide of cobalt and iron. The broken ore is roasted at red heat in a reverberatory furnace, with a very high stack for carrying away the arsenical and sulphurous fumes. When vapours cease to be disengaged, and the material begins to be pasty, the roasted product is removed from the fire, cooled, pulverized, and passed through a silken sieve. This powder is called *zaffer*. A sand free from iron, mica, talc, and lime is also calcined and thrown into cold water while still red-hot. It is then powdered, washed with hydrochloric acid, and dried. The potash should contain no lime, sand, or chloride of sodium.

The proportions for the mixture are guided by the quality of the cobalt ore, and by the tone of colour to be produced. The cobalt and sand are first added, and then the potash; the whole is introduced into clay pots having a closable hole in the bottom. The pots are placed in a glass-furnace heated by a wood fire. After 4 to 6 hours of calcination, the material is melted, and forms 3 layers: the uppermost, or dross, is composed of sulphate and arseniate of potash, and chloride of potassium; the lowest consists of ore and unmelted substances; and the middle one is the blue glass. Most of the dross is taken off with hot iron ladles, and the lowest layer of unmelted materials is removed through the bottom hole. After this hole has been closed again, the melted blue glass is ladled out into basins of cold water. The pots are charged again, and a new operation begins. The glass is removed from the water, dried, and pulverized under horizontal stones. The powder is then levigated (floated), in order to obtain various degrees of fineness.

A magnificent blue may be prepared with pure oxide of cobalt. The ore, finely ground, is treated by boiling nitric acid, which makes nitrates of cobalt and iron, and arsenic acid. The liquor is decanted, diluted, and decomposed by a solution of soda carbonate, producing a soluble arseniate of soda, and a precipitate of the carbonates of cobalt and iron, which is collected, carefully washed, dried, and calcined. The resulting cobalt oxide, holding a small proportion of iron oxide, is mixed with sand and potash.

Smalt employed for inside painting has the inconvenience of turning green and black; the difficulty of grinding it fine enough prevents its employment for artistic painting. Its principal use is for giving an azure colour to signs, which are painted with ordinary blue oil-paint, and then dusted over with smalt. It changes less in size than in oil, and is much used in fresco-painting. It dries rapidly. (Riffault.)

Ultramarine.—The preparation of ultramarine from lapis-lazuli no longer survives. Artificial ultramarine, of which some 10,000 tons are made annually, is composed approximately of 46·60 per cent. silica, 23·30 alumina, 3·83 sulphuric acid, 21·48 soda, 1·06 peroxide of iron, and traces of lime, sulphur, and magnesia. The ingredients employed are China-clay, soda sulphate, charcoal or pit-coal, and rosin; or China-clay, soda, silica, sulphur, and rosin. Their proportions may be deduced from the percentage composition just given. The raw materials are ground very fine, well mixed, pressed into muffle-furnaces, and calcined at a red heat for 12 to 36 hours, or until the sulphur is nearly burnt off. When the firing is complete, the furnaces are closed tightly, and the material is allowed to cool, requiring 5 to 6 days. The product is green ultramarine, which is roasted with finely-powdered sulphur in pans under the influence of the air. After washing, it is ground in wet mills for 2 to 5 days, settled under the action of heat, repeatedly washed, classified, dried, bolted, and packed. Gentele gives the following details of the manufacture, assuming the ingredients to be China-clay, soda sulphate, soda carbonate, sodium sulphide, sulphur, and carbon:—

All are carefully chosen and prepared. A little magnesia and lime in the clay is not objectionable; but more than 1 per cent. of iron oxide should not be admitted. The clay, after calcination, should correspond to the formula Al^2O^3, $2SiO^3$. Often clays do not present this composition, but the mechanical operations to which they are submitted remove most of the foreign materials. The preparatory working, in order to remove mechanical impurities, is effected by levigation. The washed clay is dried, slightly calcined, and immediately ground to fine powder. The floating is done by hand or power. After decanting the water, the pasty mass is collected, pressed in sacks, and dried by heat, or in the air upon porous slabs of plaster of Paris. The calcination is effected in an ordinary reverberatory furnace, at a temperature not above the beginning of a cherry-red heat. The clay is pulverized under stamps, or in an edge runner, and passed through a series of fine metallic sieves.

If the soda sulphate be employed in the anhydrous state, it should contain no free acid, and be free from iron and lead. When such cannot be had, take Glauber salt which contains no free hydrochloric acid; it is dissolved in water, and the excess of sulphuric acid is saturated with milk of lime, which at the same time precipitates the iron oxide. The clear liquor is decanted and crystallized. The lime sulphate and excess of lime remain in the deposit. The crystallized soda sulphate is slowly dried on slabs of fire-clay in the bed of a reverberatory furnace. The product is anhydrous sulphate of soda. The clear liquors may be directly evaporated, without crystallizing, in a pan always kept full of fresh liquor. At a certain degree of concentration, an anhydrous sulphate is precipitated, which is "fished," and deprived of all adhering water by slight calcination in the reverberatory furnace. The anhydrous sulphate is ground and sifted, and kept in closed vessels. This salt may be bought of manufacturers, but it is difficult in ultramarine works to dispense with the apparatus for this treatment, because, during operations, there are produced washing liquors containing sulphate of soda, which ought to be evaporated. The salt, thus prepared, always contains small proportions of sodium chloride and lime sulphate, which form no impediment to the manufacture.

The soda carbonate is also used in the anhydrous state, and can be bought as pure and dry as desired. A little soda sulphate in it presents no inconvenience. This soda carbonate is powdered like the sulphate, and kept in the same manner.

Works which do not directly use sodium sulphide in solution should be provided with iron evaporating kettles, heated by the waste heat of the furnaces. The liquors are evaporated to dryness, and constantly stirred towards the end of the operation. The sodium sulphide is powdered, and kept like the sulphate and carbonate. The sulphur employed is in refined rolls, ground and sifted. The necessary carbon may be derived from bituminous coal or wood charcoal. The impurities of the large pieces are removed by sifting, and of the small fragments by levigation; the floating charcoal is removed and dried. The caking kinds of bituminous coal are preferred, provided their percentage of ash is small. The two kinds of coal are reduced to very fine powder by trituration with balls in a revolving cylinder, or by grinding with water in granite mills. The settled powder is collected, drained, dried upon shelves, again ground, and sifted.

When the materials are used dry, it is advantageous to weigh small quantities at a time, mix them, pass through sieves of medium fineness, stir again, sift anew, and so on, until the proper result is arrived at.

The proportions of the raw materials vary, but care should be had—(1) That the soda, as sulphate or carbonate, be sufficient to saturate half the silica in the clay; (2) that the proportions of sulphur and soda be such as to produce a bisulphide or polysulphide of sodium; (3) that in the mixture there remain enough sulphur and sodium to form a mono-sulphide of sodium, when all the green ultramarine resulting from the silica and alumina is extracted.

German manufacturers compose their mixtures differently from the French. The latter employ only soda carbonate, while the former use only the sulphate, or a mixture of sulphate and carbonate. The results appear identical. In the case of the sulphate, more carbon and sulphur are employed. With the carbonate, no carbon is required, and a great deal of sulphur is needed. It appears that the German mode is the more economical.

Gentele gives the formulæ employed in factories, and which may be used for such mixtures:—

	1.	2.	3.
China-clay, calculated dry	100	100	100
Anhydrous sulphate of soda	63 to 100	—	41
Anhydrous carbonate of soda	—	100	41
Coal	17	12	17
Sulphur	—	60	13

In course of manufacture, a lye of sodium sulphide is produced, and a portion may be substituted for part of the sulphate or carbonate. It is introduced either evaporated and dry or in solution. In solutions, the proportion of sodium, and not that of sulphur, is alone considered; 100 parts anhydrous soda carbonate may be replaced by 80 of dry sodium sulphide; and 100 of dry sulphate, by 60 of dry sulphide.

The principal operation is calcination. The mixture must be brought to the proper temperature without contact of air, and the heat maintained long enough to uniformly penetrate the whole mass. Irregular and defective calcination never gives advantageous results. Under the best conditions, vessels resembling the crucibles or seggars of porcelain works are heated in ovens built of fireclay, in the shape of small porcelain ovens. There is great waste of heat in these furnaces, and in many works it is partly utilized in evaporating the mother-liquors or wet mixtures. The calcining vessels are made of good fireclay, formed upon a potter's wheel, like flower-pots; if their shape is that of seggars, the diameter is 5 in., and the height 3 in. The top edge should be level. Only a small number of flat covers are needed, because the bottom of one becomes the cover of that upon which it rests. When crucibles are employed, the cover is depressed so as to receive the bottom of the next. This appears convenient, because though the crucibles be placed close to each other, enough free space is left between them to permit the heat to circulate. With seggar-shaped vessels, it is necessary to isolate each column, and then there is danger that it will topple over.

The calcining furnaces are generally built one against the other, with a single partition wall. Fig. 16 gives an idea of the shape found to be best; *a*, fireplace; *b*, grate; *c*, ashpit with door *d*; *c*, flues going from the fireplace into the calcining chamber *i*; *f*, floor perforated with flues *c*, which may be rendered smaller by wedge bricks; *g*, brick walls. In front of this furnace is a large charging door *j*, closed with firebricks during calcination. The floor of the furnace is made level with firebricks placed on top of the arch which covers the fireplace; *k* is the arch closing the calcining chamber and provided with flues *h*, for the escape of the heated gases, which are collected in the general flue *l*, and led under the evaporating kettles or directly to the chimney. In some factories, round porcelain ovens with 3 fireplaces are used; but these take more room, and the fire is not so easily regulated. All works have a small experimental furnace containing 6 to 8 crucibles. Here the mixtures are tried before being prepared on a large scale. This small furnace is especially useful for testing new clays.

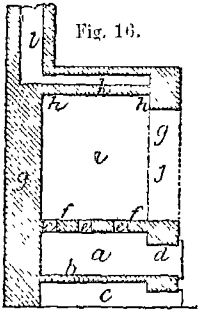


Fig. 16.

The mixture to be calcined is put in with a small shovel, and strongly stamped with a wooden tool. The calcining chamber is filled nearly to the top with piles of these crucibles, and the apertures of the flues are left free. The charging door is closed with firebricks without cementing the joints; but the outside interstices are filled with plaster of sand and clay. The firing is then begun. The temperature is slowly raised to light-red or incipient white heat. When beginning, it is necessary to make a few trials in the experimental furnace. The degree of heat is seen through an opening 1½ in. diameter, left in the charging door, and closed with a movable clay plug. The time required for a heat varies from 7 to 10 hours. The less the excess of sodium sulphide in the mixture after calcination, the longer it requires to be heated. The calcination completed, the furnace is left to cool, with all the apertures closed; as soon as the temperature has become low enough, the crucibles are removed and a new charge is put in. In this manner, 3 charges per furnace may be made in a week. The calcined mass in the crucibles has sunk, and is greyish- and often yellowish-green. The crucibles are immersed in fresh water or the washing liquors of green ultramarine, and the contents are dissolved. The separated mass is washed in tanks with several waters, and the last liquors, which are weak, are reserved for solutions or washings, instead of pure water. The ultramarine thus obtained is composed of porous fragments, large and small, which are ground wet in mills similar to those employed for porcelain compositions. The operation is continued until very great comminution is obtained. The ground powder is washed several times by decantation (*i.e.* stirring in water, settling, and removing the liquor), collected on filters, and dried. When dry, it is again stamped, and passed through fine hair sieves. In this state, it may be sold as green ultramarine, or transformed into blue ultramarine.

The cause of an inferior product must be sought in the wrong preparation of the mixture, and especially in too small an excess of sodium sulphide. Unequal colouring should be attributed to the mixture not being sufficiently homogeneous. When the crucibles break, the portions of material adjoining the cracks are coloured blue by the action of the air; but this is no great inconvenience. Brown specks show that the heat has not been sufficient, and that all the carbon has not been burned. These defective portions should be washed and treated anew like clay.

The conversion of green ultramarine into blue is effected by calcination with sulphur at a low temperature. The sulphur is transformed into sulphurous acid, and a portion of the sodium is oxidized and separated from the green ultramarine in the state of soda sulphate. The sulphur held by this green ultramarine remains whole, but combined with only a small quantity of sodium. This calcination is done by different methods, called respectively French and German.

The German mode uses small cast-iron cylinders, embedded in brickwork, above a fireplace. The back of each cylinder is immovable, and provided with a hole for resting in it one end of the shaft of a revolving stirrer. The wrought-iron front is movable, and has several holes: one for the other end of the stirring shaft, a small one below, and a larger one above, for the introduction of the sulphur. All these openings may be closed at will. There is another hole on top of the cylinder for the escape of the vapours of burning sulphur, and an iron pipe is fitted to it, in order to prevent escape of material during rotation of the stirrer. The cylinder is charged by means of a small shovel passing through the upper opening, or by removing the front, and immediately replacing it when the sulphur is in. At the same time, the shaft of the stirring apparatus is fixed in the two central holes, and a crank handle is attached to the projecting part in front. Each factory possesses several such cylinders, and their number depends upon the size of the works. Up to the present, these cylinders have been made of cast-iron, although clay would seem to be as good, and more durable. The fire being lit, the cylinder is charged with 25 to 30 lb. of green ultramarine, and closed. The stirrer is moved now and then, in order to heat the ultramarine uniformly. When the temperature has been raised to the point at which a little sulphur, projected through the upper opening, becomes inflamed, the fire is moderated, so as not to increase the heat; 1 lb. sulphur is then charged in, the stirrer is revolved, and the upper opening is left open to admit the air necessary for the combustion of the sulphur. Afterwards the stirrer is revolved more slowly, until the sulphur is burned out. A sample of the powder, taken out with a small iron spoon, appears of a bluish-green colour. More sulphur is added, stirred, and burned as long as the intensity of colour increases. When the maximum is reached, the powder is scraped into a sheet-iron box, which also receives the small quantities of material which fall during the operation. A new charge of green ultramarine is immediately put into the cylinder.

Many makers adopt an immediate washing, grinding, drying, and sifting, before the ultramarine has become entirely blue. The colour is then more uniform, because there are no green specks inside or out. The blue calcined pigment is ready for the market when it has been washed, dried, and sifted. The intensity of the blue colour depends on that of the green, but grinding generally diminishes it. Light blues are sometimes produced in the course of manufacture, and these mixed with dark ones form the medium quality. But generally the light colours are produced by addition of white pigments.

In the French method of calcination, "muffles" are used, *i.e.* furnaces into which the flame of the fireplace does not penetrate. The green ultramarine is evenly spread upon the bed, in layers 1½ in. thick. The door is closed, and the fire is urged until the sulphur projected into the muffle becomes inflamed. A shovelful of sulphur is charged in, and stirred with an iron hook, the door being raised just enough to allow of the motion of the hook. After the combustion of this sulphur, and an examination of a sample, a new quantity of sulphur is charged in, stirred, and so on, until the consecutive samples show no improvement in purity and intensity of colour. No greater heat is required than that necessary to ignite the sulphur as soon as put in. The transformation is more rapid with this mode than with the cylinders, because there is greater access of air, therefore more sulphurous acid produced, and less volatilization of sulphur. As soon as the ultramarine has acquired the desired colour, it is raked into a sheet-iron box under the door. The furnace is charged again, and the operation progresses as before.

Washing ultramarine blue by displacement affords concentrated solutions of soda sulphate, which may be utilized after precipitating their iron by lime.

Ultramarine increases in weight by combination with sulphur, and the increase, after washing the product, may amount to several hundredths. If the washings have not been thorough, the ultramarine will form compact masses in the packing barrels. (Gentele.)

For laundry purposes, ultramarine is generally put up in balls. It is thoroughly mixed with small quantities of an adhesive substance, such as gum-arabic, dextrine, or starch, worked into a thick dough, rolled flat, cut into square blocks, and rolled by hand into balls. This work is generally done by children. Ultramarine is a better bluing agent than either soluble blue or aniline. Prussian (soluble) blue particularly will impart to clothes a yellowish rusty tint after continued use. In using ultramarine for this purpose, it should be strained through a fine cloth, and not allowed to settle, lest it should spot.

Furstenau states that by employing the following mixtures, blue ultramarine may be made in one operation, instead of the green product which is ordinarily formed by the first calcination, and which requires a second calcination to give the blue tint:—

China-clay . .	100 to 110 parts.
Soda . . .	90 ,, 95 ,,
Sulphur . .	110 ,, 120 ,,
Rosin . . .	10 ,, 15 ,,
Charcoal	10 ,,

The materials are finely powdered, thoroughly mixed in the mill, and heated in round luted pots to a low red heat for 13 to 20 hours. (*Dingl. Pol. Jl.*)

Guimet has a process for making ultramarine of various colours. By the substitution of selenium for the sulphur in blue ultramarine, he obtains a brown and purple; if tellurium be substituted, he gets green and yellow.

BROWNS.—*Bistre.*—This water-colour is prepared from wood-soot as follows:—The brightest and darkest soot, from the combustion of beech-wood, are powdered and passed through a silken sieve. The powder is stirred in hot water for 24 hours, and again in another water. The liquors are collected and settled. The precipitate is mixed with gum-water, and evaporated in a stove-room to the consistency of a solid extract.

Hinau.—Luke Nattrass, of Nelson, New Zealand, has received a diploma of merit from the late International Exhibition at Vienna, for a new indigenous vegetable pigment prepared from the hinau tree (*Elæocarpus hinau*). Competent judges pronounce the pigment to be as good as if not better than sepia. It is manufactured at 6*d.* per oz., whereas the same weight of sepia costs 11*s.*

Sepia.—Sepia is furnished by the cuttle-fish (*Sepia officinalis*). The colour is extracted from a pocket filled with a brown liquor, which the fish emits to obscure the water when pursued. As soon as caught, this pocket is removed, dried in the sun, powdered, ground with a concentrated solution of potash carbonate, and boiled for some time. The solution is filtered, saturated with an acid, and left to settle. The precipitate is washed, first by decantation, and afterwards upon a filter, and then dried. This pigment forms an impalpable powder of a dark brown colour, insoluble in water or alcohol, and very fine and durable.

Sienna is an earthy substance, exported from Tuscany, and owes its colour to a hydrated oxide of iron. It is used raw or burnt. Raw sienna has a dark yellow exterior, and a light yellow interior; its powder is greenish yellow. Burnt sienna is either light or dark red when in lumps, but its powder is dark red.

Umber appears to be a hydrated silicate of iron and manganese, found native in brown lumps, adhesive to the tongue, staining the flesh, and falling to powder in water. The impurities are removed by washing, and the floated article, after settling, forms a light brown powder, which is used raw or burnt. Powdered umber, or that which has been calcined too much, reddens or blackens by the dehydration of the iron, or the superoxidization of the manganese. It is rarely employed alone, but mingles well with other colours and with slaked lime.

Vandyke-brown is derived from iron, and is very durable. It is prepared by the calcination of yellow ochres. The resulting frit is sold in lumps, grains, or impalpable powder. A Vandyke-brown is also manufactured by calcining sulphate of iron several times. The proper colour is arrived at by practice. This latter brown, which is entirely an iron oxide, and of purer colour than the preceding, is more expensive. It is often adulterated with the brown frit, a fraud detected by concentrated hot acids, which easily dissolve the pure oxide of iron, and with difficulty the ochre-brown. By mixing Vandyke-brown with red ochre and manganese binoxide, very durable browns are obtained, which do not require driers when used hot. Other durable browns may be prepared by mixing this pigment with lamp- or ivory-black.

GREENS.—*Baryta-green.*—Mix 2 parts caustic soda and 1 of potash chlorate; gradually add 2 very finely-powdered manganese; heat gradually up to dull redness, allow to cool, powder, and exhaust with water; filter, cool, and add a solution of baryta nitrate to the filtrate. A violet-coloured baryta precipitate forms; this is carefully washed, dried, and treated with ½ to 1 part caustic baryta, hydrated, and gradually heated up to redness, with constant stirring. The cooled mass is powdered, and finally washed to remove excess of baryta.

Brighton-green.—Separately dissolve 7 lb. copper sulphate and 3 lb. sugar of lead, each in 5 pints water; mix the solution, stir in 24 lb. whiting, and when the mass is dry, grind to powder.

Brunswick-green.—(*a*) Pour 3 parts saturated solution sal-ammoniac over 2 of copper-filings, contained in a vessel capable of being closed, and keep the mixture in a warm place for some weeks, when the newly-formed pigment is separated from the inoxidized copper by washing on a sieve; it is then washed with water, and slowly dried in the shade. (*b*) A solution of crude carbonate of ammonia is added to a mixed solution of alum and blue vitriol as long as it affects it; in a short time, the precipitate is collected, washed, and dried. (*c*) Lighter shades are produced by the addition of baryta sulphate or alum.

Chrome- or Guignet's-green.—(1) Fuse together 3 parts boracic acid and 1 potash bichromate at a dull-red heat on the hearth of a flame-furnace. This forms a borate of chromium and potash, with evolution of oxygen. The mass is repeatedly washed with boiling water, which causes decomposition and consequent separation of hydrated chromium oxide and a soluble potash borate. The oxide is washed and ground very fine.

(2) In boiling a solution of a chromium salt slightly acidified, to which has been added an alkaline phosphate and sodium acetate, the whole of the chromium is precipitated as phosphate. This method succeeds with the green and violet salts, chlorides, sulphates, and acetates, but not with oxalates. It is also suitable for alkaline chromates, but in this case the action of the phosphoric acid must be combined with that of sodium thiosulphate (hyposulphite), which acts as a reducing agent. The solution of chromate, to which is added a sufficient quantity of phosphoric acid or a phosphate, then of acetate, and lastly of hypophosphite, and which has been slightly acidified, is boiled for about an hour; it deposits all the chromium as phosphate, with a little sulphur derived from the hyposulphite. The phosphate precipitated is a green hydrate. It may be washed with boiling water, or, preferably, with hot solutions, first of ammonium acetate followed by ammonium nitrate. On calcination it turns grey, and contains chromic oxide in the proportion of 51·86 per cent. Alumina can be readily separated from chromium by converting the latter into an alkaline chromate, acidifying the solution slightly with acetic acid, and adding excess of sodium phosphate. The mixture is boiled and filtered, to separate the aluminium phosphate. When this is done, it is easy to determine the chromium by pouring into the liquid hyposulphite, and, if needful, a further quantity of alkaline phosphate, and boiling. The precipitate of chromium phosphate is then washed, ignited, and weighed. It yields an insoluble green colouring matter, which retains when dry a very fine shade, and may be used in painting in place of the dangerous compounds of arsenic and copper. This colour, which is perfectly inoffensive, may also be used in dyeing, as the insoluble green phosphate may be produced in the fibre. (Carnot.)

Cobalt-green is obtained by calcination of a mixture of oxides of zinc and cobalt. The first step is to prepare cobalt protoxide free from foreign metals. It is dissolved in 3 parts hydrochloric acid, and the solution is evaporated to dryness. The residue is dissolved again in 6 parts water, and a stream of sulphuretted hydrogen is passed through the liquor as long as precipitation takes place. The clear liquor, decanted from the sulphides of the foreign metals, is again evaporated to dryness, and the residue is dissolved in enough water to make 10 parts. This liquor is precipitated with soda carbonate, and if, after washing, the still wet precipitate of carbonate of protoxide of cobalt be mixed with zinc white, there is produced a reddish-violet magma, which, dried and calcined, constitutes a green mass, the colour of which is more intense in proportion as the cobalt solution has been greater.

Douglas'-green.—Barium chromate is precipitated by adding to a solution of barium chloride a sufficiency of a soluble chromate to effect complete separation; to the lemon-yellow chromate is added 20 per cent. of strong sulphuric acid, which produces a deep red by the liberation of chromic acid; the mass is then ground, and heated to redness, when it becomes green.

Emerald-green.—Form a paste with 1 part verdigris in sufficient boiling water, pass it through a sieve to remove lumps, and gradually add it to a boiling solution of 1 part arsenious acid in 10 water, the mixture being constantly stirred until the precipitate becomes a heavy granular powder, when it is filtered through calico, and dried.

Manganese-green.—Intimately mix 3 to 4 parts caustic baryta moistened with water, 2 baryta nitrate, and 2 manganese oxide; place in a crucible heated to dull redness, fuse, pour out, pulverize, digest in boiling water, wash in cold water, and dry in an atmosphere free from carbonic acid.

Mitis-green is an arseniate of copper, prepared by dissolving 20 parts potassium arseniate in 100 hot water, and mixing this solution with another of 20 parts copper sulphate. During the whole operation the mixture is stirred. A pulverulent precipitate of light-green or grass-green colour is formed, and is washed and dried. By varying the proportions, several tones and hues are produced; in the commercial article, these are generally due to introduction of foreign substances. The potassium arseniate is prepared by boiling arsenious acid in concentrated nitric acid, filtering, saturating with potassium carbonate, and crystallizing the arseniate.

Mountain-green.—(*a*) Native green carbonate or copper bicarbonate is ground to powder, either with or without addition of a little orpiment or chrome-yellow. (*b*) Add a solution of carbonate of soda or potash to a hot mixed solution of alum and copper sulphate.

Prussian-green.—A mixture of Prussian blue and gamboge.

Sap-green.—(*a*) The juice of buckthorn berries is extracted by allowing them to ferment in wooden tubs for 7 or 8 days, and pressing and straining; a little alum is added to the juice, which is evaporated down to a suitable consistence, and run into bladders to dry and harden. (*b*) Buckthorn berries, not entirely ripe, are boiled with a little water in a clean copper kettle, and upon a moderate charcoal fire. The mass is continually stirred, until it has become a kind of magma, which is pressed through cloths. The residue is washed and pressed again. The liquors are left to settle, and filtered through flannel bags, before being evaporated to the consistency of a thick extract upon a gentle fire. The thickened juice is weighed without pouring it out from the kettle (the weight of which is known); to every lb. of liquor is added 7 dr. alum dissolved in water, and the mixture is thoroughly stirred all the while. The evaporation is completed upon a water or steam bath, and continued as long as practicable without altering the colour. The product is poured into calf-bladders, and dried in the air. (Hager.)

Scheele's-green.—Dissolve 1 part powdered white arsenic and 2 commercial potash in 35 boiling water; filter, and add the solution gradually, while still warm, to a filtered solution of 2 copper sulphate as long as a precipitate falls; wash with warm water, and dry.

Schweinfurth-green.—(*a*) Dissolve 8 lb. arsenious acid in the least possible quantity of boiling water, and add it to 9 to 10 lb. verdigris in water at 120° F. (48½° C.), passed through a sieve; set aside the mixed ingredients till the mutual reaction produces the desired shade. (*b*) Dissolve 50 lb. copper sulphate and 10 lb. lime in 20 gal. good vinegar, and add a boiling-hot solution of 50 lb. white arsenic as quickly as possible; stir several times, allow to subside, collect on filter, dry, and powder. The supernatant liquid is employed to dissolve the arsenic for the next lot.

Titanium-green. — Its preparation from washed rutile or iserine is effected by the following process:—The clean ore is melted with 12 times its weight of acid potash sulphate in a Hessian crucible. After cooling, the melted mass is powdered, and digested until dissolved in hydrochloric acid diluted with 50 per cent. of water maintained at 122° F. (50° C.) The hot solution is filtered from the insoluble residue, and the filtrate is evaporated until a drop of the liquor, put upon a piece of glass or porcelain, becomes of the consistency of a magma. The whole is allowed to cool off in the porcelain dish, and the magma, composed of nearly pure titanic acid, is thrown upon a filter. The drainings are again evaporated, and furnish a new portion of titanic acid. When the magma has been sufficiently drained, it is mixed with a large volume of water holding a little ammonia, in order to prevent formation of a basic iron salt. This liquor is kept boiling for a long time, and the precipitated titanic acid, after filtration and washings, is nearly white. After several similar treatments with potash bisulphate, it may be obtained entirely free from iron. As iserine contains generally some lime carbonate, it is advisable to digest with dilute hydrochloric acid before treating with the acid potash sulphate. A concentrated solution of sal-ammoniac is poured upon the magma, and, after a thorough mixing, filtered. The titanic acid remaining upon the filter is digested in dilute hydrochloric acid, and kept at 122° to 140° F. (50° to 60° C.) until the solution is complete. The acid liquor, after addition of potassium ferrocyanide, is rapidly brought to a boil, and forms a precipitate of titanium-green, which is washed with water holding a little hydrochloric acid. The solution of titanic acid must be very acid, because if pure water be employed, and the ferrocyanide poured upon the magma, the precipitate will be a yellowish-brown, becoming green by ebullition in dilute hydrochloric acid. The green precipitate becomes white with ammonia. The liquor, filtered from the green precipitate, still contains a certain quantity of titanic acid, which ammonia will separate in the shape of a white flocculent precipitate. The dry titanium-green, obtained either from rutile or iserine, is a dark-green powder. It is decomposed at 212° F. (100° C.). Its desiccation should therefore be carefully conducted. By this method, any titaniferous iron ore will produce a green as handsome as that prepared from rutile. Moreover, the liquor holding the double sulphate of iron and potash will give a Prussian-blue by addition of potassium ferrocyanide. (Riffault.)

Verdigris is a basic hydrated copper acetate, composed of variable proportions of bibasic and tribasic copper acetates. It is manufactured in France by oxidizing very thin pieces of old sheet copper, heated to 176° F. (80° C.), with a solution of copper acetate, and then immersing them in the skins of pressed grapes, which are in a state of acetic fermentation. After a time, the copper plates are removed from the skins, dried in the air, dipped into water, and again laid in layers of grape-skins. When this has been repeated 5 to 7 times, the verdigris is scraped off, kneaded in wooden troughs, and packed in leather bags. Its desiccation is completed in the air. It is also prepared by covering copper plates with vinegar It is a pure green or bluish-green, according to the proportion of sesquibasic acetate it contains. It is highly poisonous, and not durable.

Zinc-green.—Zinc oxide, 5 lb.; cobalt sulphate, 1 lb. Mix with sufficient water to form a paste, and heat to redness; a deep green pigment results. With 10 parts zinc oxide, and 1 part cobalt sulphate, a grass-green powder is obtained; and with 20 parts zinc oxide a light grass-green pigment is produced, capable of being used instead of arsenic-green. This green is permanent in contact with lime (as in mortar, &c.), and has thus an advantage over green made from mixtures of chrome-yellow and Prussian blue. (Elsner.)

REDS.—*Brazil-wood Lake.*—(*a*) Digest 1 lb. ground Brazil-wood in 4 gal. water for 24 hours, boil ½ hour, and add 1½ lb. alum dissolved in a little water; mix, decant, strain; add ½ lb. tin solution, again mix well and filter; to the clear liquid cautiously add a solution of soda carbonate while a precipitate forms, avoiding excess; collect, wash, and dry. The shade will vary according as the precipitate is collected. (*b*) Add washed and recently-precipitated alumina to a strong filtered decoction of Brazil-wood.

Carminated Lake.—(*a*) The cochineal residue left in making carmine is boiled with repeated portions of water till exhausted; the liquor is mixed with that decanted off the carmine, and at once filtered; some recently-precipitated alumina is added, and the whole is gently heated and well agitated for a short time; as soon as the alumina has absorbed enough colour, the mixture is allowed to settle, the clear portion is decanted, and the lake is collected on a filter, washed, and dried. The decanted liquor, if still coloured, is treated with fresh alumina till exhausted, and thus a lake of second quality is obtained. (*b*) To the coloured liquor obtained from the carmine and cochineal as just stated, a solution of alum is added, the filtered liquor is precipitated with a solution of potash carbonate, and the lake is collected and treated as before. The colour is brightened by addition of tin solution.

Carmine.—Boil 1 lb. cochineal and 4 dr. potash carbonate in 7½ gal. water for ¼ hour. Remove from the fire, stir in 8 dr. powdered alum, and allow to settle for 20 to 30 minutes. Pour the liquid into another vessel, and mix in a strained solution of 4 dr. isinglass in 1 pint water; when a skin has formed upon the surface, remove from the fire, stir rapidly, and allow to settle for ½ hour, when the deposited carmine is carefully collected, drained, and dried.

Cassius-purple.—This is the precipitate which takes place when solutions of gold and tin chloride are mixed under proper conditions. The preparation of the purple of a constant composition is effected by the following process:—Gold bichloride is prepared by dissolving 20 gr. gold in 100 of aqua regia, made with 4 hydrochloric acid and 1 of nitric acid. The solution is evaporated to dryness in a water-bath, in order to expel the excess of acid, and the remaining gold chloride is dissolved in 75 gr. water. Pure granulated tin is then introduced into the filtered liquor, which after some time becomes brown and turbid. After standing several days, all the gold is in the state of stannate of protoxide, which is separated from the remainder of the metallic tin. The product is collected upon a paper filter, carefully washed, and dried at a gentle heat.

Cobalt-pink is a mixture of the oxide of this metal with magnesia. It is durable, and more or less pink according to the proportion of cobalt. It is an expensive pigment, used only for fine painting. Its preparation consists in making a paste of carbonate of magnesia with a concentrated solution of cobalt nitrate. The paste is dried in a stove, and then calcined in a porcelain crucible.

Cochineal-lake.—(*a*) Digest 1 oz. coarsely-powdered cochineal in 2½ oz. each water and rectified alcohol for a week: filter, and precipitate by adding a few drops of tin solution every 2 hours, till the whole of the colouring matter is thrown down; wash the precipitate in distilled water, and dry. (*b*) Digest powdered cochineal in ammonia water for a week; dilute with a little water, and add the liquid to a solution of alum as long as any precipitate (lake) falls. (*c*) Boil 1 lb. coarsely-powdered cochineal in 2 gal.

water for 1 hour; decant, strain, add solution of 1 lb. cream of tartar, and precipitate with solution of alum. By adding the alum first and precipitating the lake with the tartar, the colour is slightly changed.

Colcothar is a red iron sesquioxide, which forms a very durable and bright colour, and is obtained by the calcination of green iron sulphate (copperas) upon iron plates until it has lost its combined water and become white. It is pulverized, placed in stoneware pots, and submitted to red heat. During the operation, sulphurous and sulphuric acids distil over, and the residue of the retort is a hard mass, which is coarsely powdered, washed, dried, finely ground, and sifted. The finer qualities are obtained by levigation (floating). The latter, after drying, are sometimes calcined anew, in order to increase their brightness. Colcothar is also produced in the wet way by mixing a solution of iron sulphate with another of sodic carbonate or bicarbonate. There forms a soluble soda sulphate and a precipitate of carbonate of protoxide of iron, which is soon transformed into hydrated iron sesquioxide. This is washed, dried, and calcined at a red heat in clay crucibles. When precipitation is effected in hot liquors, the colcothar is finer, more velvety, and deeper in colour. It may be mixed with other iron colours, or calcined with lampblack, for producing various tones.

Indian Red.—(*a*) Iron sulphate is calcined until the water of crystallization is expelled, then roasted by a fierce fire until acid vapours cease to arise, cooled, washed with water till the latter has no acid reaction, and dried. (*b*) Calcine 11 parts common salt with 25 parts green iron sulphate; well wash with water, dry, and powder. (*c*) The finest Indian red, or "crocus," usually undergoes a second calcination at a higher temperature.

Madder-lake.—(*a*) Tie 2 oz. madder in a cloth, beat it well in 1 pint water in a stone mortar, and repeat the process with about 5 pints fresh water till it ceases to yield colour; boil the mixed liquor in an earthen vessel, pour into a large basin, and add 1 oz. alum dissolved in 1 pint boiling water; stir well, and gradually pour in 1½ oz. strong solution of potash carbonate; let stand until cold, pour off the yellow liquor from the top, drain, agitate the residue repeatedly in 1 qt. boiling water, decant, drain, and dry. (*b*) Add a little solution of lead acetate to a decoction of madder, to throw down the brown colouring matter; filter, add solution of tin or alum, precipitate with solution of soda or potash carbonate, and proceed as before. (*c*) Macerate 2 lb. ground madder in 1 gal. water for 10 minutes; strain and press quite dry; repeat a second and third time, and add to the mixed liquors ½ lb. alum dissolved in 3 qt. water; heat in water-bath for 3 to 4 hours, adding water as it evaporates; filter first through flannel, and when cold enough through paper; add solution of soda carbonate as long as precipitate falls; wash the latter till the water comes off colourless, and dry.

Red-chalk or Reddle.—An earthy red hæmatite, found in all countries and most geological formations.

Red-lead.—This is prepared on the large scale by the oxidization of metallic lead in a reverberatory furnace with two fire-hearths covered by an arched roof, situated at the extreme end, separated from the middle hearth, in which the lead lies, by fire-bridges, and fed with coke. The lead, about 10 per cent. being hard, is worked about by an iron tool as soon as melted, the "massicot" or protoxide formed being constantly pushed to the side. The temperature must be kept at low redness, or the oxide will melt. The treatment is sustained for 24 hours; the massicot is then removed, ground, levigated, and again exposed in the furnace to the same heat for 48 hours, or till it exhibits a bright-red colour on cooling. The furnace is then closed and allowed to cool as slowly as it will. The product is "minium," or "red-lead." Mercier finds that it is not desirable to manufacture red-lead in trays in the same furnace that serves for the production of the original massicot, owing to the fluctuation of the temperatures; the best degree of heat is that approaching, but not quite reaching, a dull red, and a special furnace has been constructed for the maintenance of the temperature for a long time, on the manufacturing scale. The red-lead produced is brighter in tint the greater the increase in weight of the massicot used, the maximum increase being about 2 per cent.

Vermilion.—(*a*) Melt 1 part sulphur, and gradually add 5 to 6 parts mercury, continuing the heat till the mixture swells up; then cover the vessel, remove it from the fire, and when the contents are cold, reduce to powder, and sublime in a closed vessel so placed in a furnace that the flames reach about half the height. Gradually increase the heat till the lower part of the subliming vessel becomes red hot: break the cold sublimate, grind in water to fine powder, sift, and dry. It is a black sulphide of mercury. This, reduced to powder and sublimed, gives a filamentous mass of violet hue, appearing scarlet on trituration. (*b*) Grind together 300 parts mercury and 114 flowers of sulphur for some hours, and gradually add 75 caustic potash dissolved in 450 water; continue the grinding for some time longer, and gently heat the mixture in an iron vessel, first stirring constantly, afterwards at intervals, keeping the temperature as nearly as possible at 115° F. (46° C.), and renewing the water as evaporated. When reddening commences, increased care is needed, and when the colour is nearly fine, the heat must be maintained at a lower degree till a rich colour is produced. Every precaution must be taken against inhaling the vapours. (*c*) To a mixture of 4 parts soda hyposulphite and 4 zinc sulphate in dilute solution, add drop by drop a solution containing 1 part corrosive sublimate. Heat the whole gently for 60 hours at 112° to 130° F. (45° to 55° C.)

WHITES.—*Alum - white.*—Dry mix 2 lb. powdered alum, 1 lb. honey; powder, calcine to whiteness in a shallow dish, cool, wash, and dry

Baryta-white.—(*a*) Natural baryta sulphate, barytes, or heavy spar, is employed in the manufacture of a handsome innocuous white colour, fast, and resisting most reagents, but with little body or covering power. This white, fixed with glue size, is largely employed in the manufacture of paper-hangings, and for adulterating white lead and zinc white. In preparing it, the whitest lumps are picked out, coarsely broken, and heated in reverberatory furnaces to disintegrate the substance, and produce a finer degree of pulverization. The grinding is done dry, and the resulting fine powder is thrown into tanks of water, stirred, and let stand a little while, when the heavier and coarser particles fall to the bottom. The milky-looking supernatant water is decanted into settling basins, where the lighter suspended material deposits; after another decantation of the clear liquor, the pasty white is collected, and dried in the air or a stove-room.

(*b*) Artificial baryta sulphate, found in the market under the name of *blanc fixe* (fast white), is much better than native sulphate. According to Kuhlmann, the cost of the acids constitutes the main expense of manufacture. By putting natural baryta carbonate (witherite) in contact with the vapours escaping from salt-decomposing furnaces or from lead chambers, he succeeded in saving a large proportion of the uncondensed vapours. In his works, the baryta, dissolved by the condensed acids, is converted into the artificial sulphate by an addition of sulphuric acid. The recovered nitric and hydrochloric acids return to take part in a new operation, and increase the yield. In another process of Kuhlmann's, a mixture of natural baryta sulphate, manganese chloride, and coal, is transformed at a high temperature into insoluble manganese sulphide and barium chloride, which is easily separated by washing. The reaction is represented by the formula—

$$\mathrm{BaO, SO_3 + MnCl + 4C = BaCl + MnS + 4CO}$$

The coal intervenes as a deoxidizing

agent, and is converted into carbonic oxide. He is thus able to transform native baryta sulphate into barium chloride without a loss of more than 3 to 4 per cent. of baryta sulphate. The transformation is effected in large reverberatory furnaces, similar to those employed for decomposing salt in soda-works, with a hearth divided into two compartments by a low wall. When these furnaces have been heated, the portion most remote from the fireplace is charged with a finely-pulverized mixture of native baryta sulphate and bituminous coal; and above it is poured the liquid residue from the manufacture of chlorine, the free acid of which has been previously saturated with chalk or native baryta carbonate. The mixture is well stirred, and thickened by heat. When it has become a thick paste, it is passed over the partition wall, with proper iron tools, into the compartment near the fire. There the mass swells, and soon disengages small jets of carbonic oxide. After an hour's calcination at red heat, the semi-fluid paste, which has little more consistency than that of crude soda, is removed from the furnace, and, when cold, forms a black mass of barium chloride, with manganese and iron sulphides, and a small proportion of baryta hyposulphite. After several days' exposure to the air, the mass becomes disintegrated, and the hyposulphite passes to the state of sulphate. The substances are then lixiviated with hot water in an apparatus disposed like that for crude soda. The liquors are a clear solution of nearly pure barium chloride. Should there be slight excess of barium sulphide, causing a yellow colour, there is poured in, until complete decoloration, a solution of manganese chloride (residue of the manufacture of chlorine) which has been deprived of iron by digestion with powdered baryta carbonate. Conversely, any excess of manganese chloride is separated with barium sulphide. The solution of barium chloride, obtained from the raw product, marks 24° or 25° B. When purified in the manner indicated, chamber acid (sulphuric), diluted with water to 30° B., is poured in as long as a precipitate forms. The whole is well stirred and let stand. The baryta sulphate is rapidly deposited, and the syphoned liquors constitute a hydrochloric acid marking 6° B. The artificial sulphate thus obtained is washed, to remove the last trace of free acid, drained to the consistency of a firm paste in cloth filters, and the filters are pressed, or subjected to centrifugal action. When the paste has become thick enough, it is packed in barrels, and contains 30 to 32 per cent. of water. It may be dried and moulded like white lead, but in the majority of cases it is more advantageous to use it in the pasty state, because, once dried, it does not require the same degree of comminution.

Chinese White.—Mix finely-ground zinc-white into a cream with mucilage of gum tragacanth, grinding with a glass muller.

Lead Sulphate.—Precipitate the pigment by adding diluted sulphuric acid to an acetic or nitric acid solution of litharge; wash, and dry.

White-lead.—There are several processes for making this pigment.

(*a*) American process.—This is a modification of the Dutch method. The purest metallic lead is used. Originally it was subjected to the chemical operation in the form of loose rolls of sheet-lead. The American method is to cast the lead into circular gratings, looking very much like shoe-buckles. In whatever shape, the lead is put into earthen jars, with a little vinegar at the bottom, the lead being supported by earthen ledges from coming into contact with the vinegar. Sometimes the pots have openings in the sides to permit a free circulation of the vapours set free in the process. An immense collection of the jars, tens of thousands in number, is then packed in alternate layers with layers of some fermenting material which will give out carbonic acid gas. Originally stable manure was employed; now tan bark is preferred. The layers of jars and bark are carried up sometimes 20 ft. high, the bark being kept out of the jars by sheets of lead and boards. The fermentation sets free much carbonic acid. Basic acetate is first formed on the surface of the lead in the pots, which is decomposed by the carbonic acid gas, forming carbonate and free acetic acid. The latter acts again on the lead. Very little vinegar is required; and the process goes on continuously, assisted by the heat of the fermentation, until, at the end of 10 or 12 weeks, fermentation stops. The process is then at an end. The stack is taken to pieces, and the lead is found in its original form, though increased in bulk and weight, and converted into a very white and soft carbonate. If the conversion has not been thoroughly done, a core of metallic or blue lead will be found in the interior of some of the pieces. The pieces of lead are thrown into large tanks filled with water, in which they rest upon copper shelves full of holes. They are beaten to separate and pulverize the carbonate, the water preventing the fine dust from poisoning the air and injuring the workmen. Grinding and washing in water then follow, until the carbonate is reduced to an impalpable powder. It is then dried in steam pans or upon tile tables, and put up for the market. The carbonate obtained in this way is superior; but a fair article is made by boiling solutions of nitrate or acetate with litharge, and precipitating the solution with carbonic acid. White lead is not alone employed as the best white paint; but it constitutes the body of almost all other paints, it being coloured by intermixture with other pigments. (*Scient. Amer.*)

(*b*) Dutch process.—The Dutch process comprises the following operations:—(1) Fusion and casting the lead in sheets or grates (buckles). (2) Alternate layers made of lead and stable manure, or spent tan. The lead is put into pots holding weak acetic acid, and remains in the beds 35 to 40 days when stable manure is employed, and 70 to 90 when spent tan is used. (3) Successive uncovering of the layers of lead, most of which has become carbonate. Separation of the white-lead from the non-corroded metal. First grinding and separation of the blue lead. (4) Grinding the white-lead with water under stones. (5) Moulding and drying the floated white-lead. (6) Grinding and sifting the dry white-lead, and packing in barrels that which is to be sold powdered. (7) The white-lead which is to be made into paste with oil is not sifted, but mixed with 7 to 10 per cent. of its weight of oil, in a closed stirrer, and passed between cast-iron rollers. When the paste has become fine and homogeneous, it is received in a tank filled with water, from which it is taken and packed for sale.

(1) Fusion is effected in cast-iron kettles, and no dangerous fumes are emitted except from old lead or the residues of previous operations, still covered with carbonate. The kettle is placed under a hood receiving its draft from the chimney of the furnace. The top edge of the furnace is connected with the hood by a metallic cylinder, having doors which open for charging the lead, or for casting the fused metal. These precautions seem sufficient.

(2) The buckles or thin sheets of lead, rolled into spirals, are put into earthenware pots, and there supported upon 2 or 3 projections, the vinegar being at the bottom of the pot.

(3) In separating the white-lead from the non-corroded metal, the workman picks up by hand the large and slightly adhering scales of white-lead, and separates the remainder by twisting and bending the non-corroded lead. This is generally done in the bed itself, or in a special room, where the corroded metal is carried as it comes from the pots. The buckles or sheets, with some still adherent white-lead, are put one by one upon an endless cloth, which carries them to an inclined hopper, from which they pass between two pairs of grooved rollers, and thence through an inclined cylindrical sieve. What passes through the holes of the sieve is received into a hopper, which delivers it into a trough on wheels. The metallic

lead falls from the lower opening of the sieve into another trough. The whole of the machinery is enclosed in tight wooden partitions, the only free opening of which is that for the passage of the endless cloth. The trough, filled with white-lead, is removed when the dust has subsided, and its contents are mixed with the scales picked up by hand.

The next dry grinding is effected in an edge-runner mill. The ground lead is shovelled into a cylindrical metallic sieve with fine holes, and enclosed in a wooden box. The powdered white-lead is collected at the bottom of the box, and the small flattened particles of metallic lead fall from the lower end of the sieve into a special receiver. The sifted white-lead is mixed with water, and thoroughly ground under millstones.

Danger ceases to exist when the separation of the scales, their grinding and sifting, are effected under water, or subjected to sprays of water immediately after leaving the grinding apparatus.

(4) The white-lead is mixed with water, to form a soft paste, which passes through several horizontal mill-stones before it is thoroughly comminuted.

(5) The soft paste is poured into conical earthenware pots, which are dried in a stove-room. The greater part of the water is expelled, and the blocks, becoming contracted, are easily removed from the pots. Their thorough drying is finished in another or the same stove-room. The sides of the pots are coated with white-lead, which is scraped off with an iron tool, or by washing in water.

Some white-lead is sold, after drying, in the shape of conical blocks, wrapped in paper, and put into barrels without breaking them. Some is not put into pots, but the soft paste is poured upon a cloth, which is then folded so as to form a square flat bag. Several such bags, separated by square wooden trays, are afterwards squeezed in a hydraulic press, which expels the greater part of the water. After unfolding the cloth, the block of white lead is cut into prisms or bricks, having sufficient consistency to be carried immediately into the drying-room.

(6) Most of the white-lead in lumps requires to be ground and sifted again before it is ready for sale. This second grinding is done with an edge-runner mill. The ground stuff is shovelled into the hopper of a cylindrical silken sieve, enclosed in a wooden box, where the fine white-lead falls. That which does not pass the sieve is collected in another box, and re-ground. The sifted white-lead is removed from its box after the dust has subsided, and packed in barrels by shaking or ramming.

(7) The prisms of white-lead are ground in a kind of coffee-mill, and the powder is put into a horizontal cylinder with oil, and mixed by iron paddles fixed to the shaft running through the cylinder. Thence the paste passes between cast-iron rollers, and becomes fine and homogeneous by more oil being added if necessary. The finished paste is kept under water in large tubs. When white-lead is ground in oil, it is not necessary to reduce it to fine powder, and this avoids one of the most unwholesome operations. It is therefore advantageous that all white-lead (by far the greater part is always ground in oil) should be mixed with oil in the works themselves. English factories deliver the greater part of their product in the shape of a paste holding 8 to 9 per cent. of oil. (Riffault.)

Pélouze observes that the vinegar used is made from inferior beer, and contains but a small proportion of acetic acid, less than 1½ per cent. of the weight of lead employed; and in good operations nearly the whole of the metal is transformed into white lead. No white-lead is obtained when drafts are not established between the different parts of the beds. The theory of the process is therefore simple. The air produces oxidization, and the vinegar, volatilized by the heat of the fermenting manure, unites with the lead oxide, being then displaced by the carbonic acid disengaged by the manure. A considerable portion of acetic acid is found in unwashed white-lead made by the Dutch process.

(*c*) French process.—The chemical reactions on which it is based are as follows:—If a solution of basic lead acetate be treated with carbonic acid, part of the oxide is converted into lead carbonate, and the remainder becomes neutral acetate (sugar of lead). By adding a new portion of litharge (lead oxide) to the solution of neutral acetate, this becomes basic again by the solution of the oxide. These reactions permit the manufacture of white-lead by a continuous and economical production of basic acetate.

In practice, a solution of basic lead acetate, marking 16° to 18° B., is made by boiling a solution of neutral acetate with very finely powdered litharge. When the litharge has dissolved, and the basic solution is well saturated, the liquor is decanted from the impurities into a closed vessel. Carbonic acid is then introduced, being previously well washed. When all the basic excess of oxide is transformed into carbonate, the liquors are allowed to settle. The carbonate falls to the bottom, and the supernatant solution of neutral acetate is decanted, to be boiled again with oxide, and become basic acetate. Each operation entails a loss of neutral acetate, which must be replaced. The settled carbonate is first washed with a little water, added to the decanted solution of acetate. The washing is continued with larger quantities of water. The paste of white-lead is put into pots, and dried in the stove-room. This white lead is in impalpable powder, and as white as snow, but has less density and body than Dutch.

In the manufacture as conducted at Portillon, near Tours, the lead oxide is moistened with water, and spread over a wooden floor above 2 saturating pans, copper-lined, supplied with stirrers composed of a wooden frame with bronze projections, which reach to about $\frac{1}{2}$ in. from the bottom. One pan is raised above the other, so that the excess of liquid in the upper runs by a spout into the lower. The latter, at the middle of its height, is connected with a duplex bronze pump. The two pans are filled with water rendered acid by about $\frac{1}{40}$ of pure pyroligneous acid marking 30°. While the stirrers are in motion, damp lead oxide is put in, and becomes partially dissolved. The pump then forces the solution into 3 large copper-lined tanks, connected with each other, and having stirrers kept in motion during the operation. These 3 apparatus are provided with pipes and inverted gutters, perforated with numerous small holes, through which a continuous stream of carbonic acid escapes. The sp. gr. of the solution is 5° B. By this operation the pump takes the solution of basic acetate from the saturating pans, and carries it into the precipitating tanks, where it is brought into contact with the carbonic acid. White lead is immediately formed, and the liquid, which must still retain a certain proportion of basic acetate, passes into the settling tanks, where the white-lead deposits. The liquor then goes back to the saturating tanks, and the operation is repeated.

When the settling tank is sufficiently filled with white-lead, the solution is passed into other vessels, and the white-lead is washed in washing tanks provided with wooden horizontal stirrers having a rotary motion. The settled pigment is covered with twice its volume of pure water, and stirred; 3 washings take place, and at each the material is allowed to deposit, and the water above is decanted. The white-lead is conducted into large basins built of porous stone, which absorbs part of its dampness. After a few days, the material is divided into blocks, pounded by wooden vertical stamps, put into boxes holding about 8 cwt., and carried to the drying-room.

A modification of this process is practised in England. The lead is smelted in a cast-iron kettle with a spout, which delivers it upon the bed of a large reverberatory furnace, into which air is constantly injected by a ventilator. The lead becomes divided, offers a large surface to the air, and runs into a channel whose lateral sides are perforated with small holes. The lead is oxidized, and the litharge escapes through small apertures. The silver, if any, remains at the bottom of the channel. This mode of preparing litharge is very easy and rapid. The litharge is then finely divided, and after being moistened with 1 per cent. of lead acetate dissolved in water, is put into horizontal troughs, closed on top and inter-communicating. A stream of impure carbonic acid, produced by the combustion of coke in a reverberatory furnace, with air projected by centrifugal ventilators, passes meanwhile through the layers of oxide. The pressure exerted by the ventilators is sufficient to overcome the resistance of the layers of litharge. The gases are cooled in pipes immersed in water. To bring all the particles of oxide into contact with the carbonic acid, and aid the combination, a system of rakes, moved by machinery, keeps the mass constantly stirred. The white-lead thus obtained is good for painting, perfectly white, covers well, and is preferred in England to that prepared in the wet way, which contains crystalline particles.

(*d*) German process.—The method in use in Germany is a modification of the Dutch, plates of lead being simultaneously exposed to the action of the air, aqueous vapour, carbonic acid, and the vapour of acetic acid; the product covers as well as the best substance made by the Dutch process, and better than that made by the French, being denser and of a finer grain; it is never crystalline, and hence requires less oil for the preparation of paint. The best approximates in composition to the formula $2CO_2 . PbO + PbO . H_2O$; some specimens contain less lead hydrate than this, but when the proportion of this constituent becomes too low, the product is hard and useless; as a rule, the more hydrate is present the better the white-lead. Excess of carbonic acid in the atmosphere of the white-lead chamber has a tendency to produce a crystalline structure: when the composition approaches that of neutral carbonate, it is extremely crystalline; the residues of knottings left on the sieves approximate to the same composition, and are useless as pigment. The following analyses of various qualities are typical, illustrating the connection between the composition and the covering properties:—

No. 1. First quality (fleur de ceruse).
2. Good ceruse; second quality.
3. Usable ceruse; third quality.
4. Bad; residues.
5. Abnormal chamber products; useless.

	Lead oxide.	Carbonic acid.	Water.
No. 1.	86·80	11·16	2·00
2.	86·24	11·68	1·81
3.	86·03	12·28	1·68
4.	84·69	14·10	0·93
5.	83·47	16·15	0·25

The richer in carbonic acid the more grey is the tint. When the acetic acid is too small in quantity, anhydrous lead oxide is sometimes formed; this is yellow or red, and its presence considerably damages the lead; a specimen had the following composition:—

Lead oxide	93·70
Carbonic acid	5·30
Water	0·90
Representing—	
Lead carbonate	32·22
Lead hydrate	12·05
Anhydrous lead oxide . .	55·64

(Weise.)

(*e*) Kremnitz process.—This process requires lead oxides and acetic acid, or lead acetates and carbonic acid. Among the oxides, litharge and massicot are the best; red-lead does not suit. The acetic acid should be free from substances which would discolour the white-lead and impair its value. When acetate is used, the neutral acetate (sugar) of lead, and the basic solutions called extract of Saturn and Goulard's water, are best.

Following is the manner of manufacturing:—If the oxide is in big lumps, it is ground to powder, which need not be very fine. Litharge seldom requires this operation. The oxide is mixed with acetic acid or lead acetate, and sufficient water is added to make a consistent paste. This is spread in thin layers over trays covered with sheet-lead, disposed one on another in a room for the purpose, into which the carbonic acid enters, and, being absorbed, combines with the oxide to make lead carbonate or white-lead.

The absorption is hastened by stirring with rakes, and thus presenting fresh surfaces to the action of the carbonic acid. If the gas is not sufficiently damp, water is added to the mixture, to render it more ready to absorb the carbonic acid. As the operation progresses, the oxide gradually becomes white; and when the mixture is free from colour, the treatment is finished, since all the oxide has been transformed into carbonate. The length of the operation varies with the proportion of acetic acid or acetate employed, the rapidity of production of carbonic acid, and the attention given in stirring and maintaining the dampness. With the proportions given further on, a sufficiently rapid production of carbonic acid, and proper care, the carbonation requires 3 to 6 days.

It is economical to mix at once part of the oxide with the whole of the acetic acid or acetate, and when this oxide is very nearly transformed, to add a new proportion without more acetic acid or acetate. This new mixture being exposed to the action of the carbonic acid, the free oxide is very rapidly converted into carbonate. A new proportion of oxide is again added, and the operation is continued as before, always with a proper amount of moisture. These successive additions of oxide are repeated until the acetic acid or acetate is reduced to $\frac{1}{4}$, or even less, of that which was in the original mixture. When the carbonation is finished, the mixture is spread in a stove-room, allowed to dry, ground in a mill with water in the ordinary manner; the ground and floated product is dried again, and is white-lead for painting and all other purposes. The carbonated mixture may be ground immediately after removal from the trays, without drying first; but the latter operation improves the quality. For 100 lb. of lead oxide, is used the same weight of a solution of acetic acid which contains 18 pints of No. 24 or proof vinegar. When using lead acetate, either solid or in solution, take a quantity yielding the proportion of acetic acid just mentioned.

(*f*) Pattinson process. — Pattinson's white-lead is distinguished by its composition, which is a basic chloride and an oxychloride, instead of a combination of oxide with carbonic acid. He prepares his white-lead from crude galena (lead sulphide), which often contains silver. This latter metal is collected, and the sulphur is also employed. The finely-powdered galena is heated in closed leaden vessels with concentrated hydrochloric acid, which is produced in large quantities in soda works, and is very cheap. By this treatment the sulphur is transformed into sulphuretted hydrogen, which is burned in the furnaces of sulphuric acid works, and assists in the production of sulphuric acid. The lead is transformed into chloride, and as this salt is but slightly soluble, large volumes of boiling water are employed to separate the silver sulphide contained in the galena. The boiling solution of lead chloride, to pass to the basic state, needs to be mixed with lime-water very rapidly, in order to obtain the basic chloride in the shape of an exceedingly fine powder which covers well. The proportion of lime also should be exactly calculated for neutralizing half the chlorine of the lead chloride, and the precipitated basic salt should contain equal atoms of chloride and oxide of lead. The clear solution of lime is in one tank, the hot one of lead chloride in another, and they are mixed by regulating their running into a third tank. An inconvenience is, that the chloride of lead, being but slightly soluble even in boiling water, very large vessels are needed, and the consumption of fuel to heat the water is considerable.

Pattinson's white-lead has a slight brownish shade, which is scarcely sensible when a small proportion of black or blue is added. On the other hand, it covers particularly well. It is very bulky, possesses great body, and absorbs a large proportion of oil.

Precautions.—The use of petroleum to prevent the lead-poisoning of workmen is useful. Fastré verified that most cases of lead-poisoning resulted from absorption of white-lead through the pores of the skin. He remarked that men at work with the scrapers, or the horizontal grinding-stones, are affected, as well as those who pound the white-lead; and yet the scraping and water-grinding produce no dust. In such work it is through absorption by the skin the poisoning is effected. Fastré found in petroleum an energetic antidote. Before beginning work, at midday, and in the evening, the workmen are obliged to wash their hands with petroleum. The cases of lead-poisoning have decreased 90 per cent. Benzole, existing in the petroleum, scours the skin, and takes the white-lead completely away; the fat substance in the oil prevents the absorption of lead-salts during work. This simple process, which is said to give such good results, may supply useful applications in many industries where the workman has to handle salts of copper, mercury, and other such products. (*Revue Indust.*)

Composition of Commercial Samples.—As the result of examination of hundreds of samples, Wigner and Harland express a decided opinion that white-lead consists of a mixture of a neutral carbonate with a hydrate, and that its value as a pigment depends almost entirely upon the relative proportions of these ingredients. In general terms, if lead is converted into a hydrate, it will combine with oil, and form a kind of paint or varnish; but this, although it will spread over the surface of the material to be covered, will not really cover it in such a way and with such a degree of opacity as to hide the natural colour of the substance over which it is spread, but, on the contrary, it will appear like a muddy film of varnish or lacquer spread over it. Or, taking the other extreme, if the compound consists entirely of lead carbonate, it will form an emulsion with the oil, resembling, to some extent, the emulsion which chalk will form with water or syrup, and although it will possess a certain degree of opacity, it will not cover the material in such a way as to render it suitable for paint. They come to the conclusion that the combination of the two compounds is necessary to secure a good paint—that is, the hydrate must be present to enable the mixture to form a paint instead of an emulsion, and the carbonate must be present to give covering power.

The results of analyses of the best brands of commercial white-lead show that the percentage composition corresponds in most cases with admixtures between certain limits. Muter appears to have practically hit upon the true proportion, which he puts down as 3 equivalents of lead carbonate and 1 of hydrate.

The facts brought forward seem to give evidence of the reasons why zinc white, carbonate of magnesia, oxide, and other metallic carbonates and similar substances, have not been used as paints with success. In the case of the white-lead, a positive chemical compound has been formed, and the 75 per cent., or thereabouts, of lead carbonate present has been dissolved in the chemical compound, and so a paint has been formed which possesses a covering power in excess of any other. Until some means can be devised by which some other substance can be dissolved in the same way in a chemical compound, so as to form a paint possessing characters somewhat different from those of a mere emulsion, it seems useless to argue that, as regards durability or covering power, they can equal a good well-manufactured sample of white-lead; and while inventors attempt, in order to increase the yield of paint from a ton of lead, to precipitate the whole of it in the form of carbonate, it is useless for them to think that such paint can possess a covering power to be compared with that of a genuine article. (*Analyst.*)

Whiting.—Spanish white and Paris white are practically the same article in different degrees of fineness, all being simply chalk, ground, elutriated, balled, and dried. Grinding-mills break up the chalk and mix it with water, which is constantly flowing in. On leaving the mills, the mixture passes along a series of wooden troughs, where the sand, which has a greater specific gravity than the chalk, is deposited, the chalk passing on into the settling-pits. On being taken from the pits, the whiting is partially dried on a floor under which hot flues run; then cut up into large rough lumps, and placed in racks on cars which run round on tramways into an immense oven. The heat from the flues in this oven is greatly increased by an air-blast, which also carries off the moist exhalations from the drying whiting; 12 hours on the heated floor and 12 in the oven thoroughly dries the whiting, and it is ready for packing or the putty factory. Paris white of fine quality is used for finishing parlour walls, adulterating paints, making paper heavier and whiter, &c. For this purpose, what is called cliff stone, a better and harder quality of chalk, is used. Paris white is made much on the same principle as whiting, only more carefully washed and more slowly dried.

Spanish White.—After picking out the coarser impurities, the chalk is ground in a mill and formed into rolls, in which shape it is found in the trade. For painting purposes, it is still further purified by stirring in clear water, allowing it to settle, and decanting the first water, which is generally yellow and dirty. The washing is repeated, and the chalk is floated out into another vessel, after passing through a silken sieve. After settling, the water is decanted, and the pasty white residue is formed into cylindrical rolls, 3 to 4 in. long, and 1½ to 2 in. diameter. These are allowed to harden and dry in the air, and are then ready for painting, whitewashing ceilings, and for distemper painting with size.

Wilkinson's White.—Litharge is ground with sea-water till it ceases to whiten, and is then washed and dried.

Zinc-white. — (*a*) Zinc chloride or sulphate is precipitated by means of a soluble sulphide—sodium, barium, and calcium sulphides have been used—and precautions are taken that no iron present is precipitated. The precipitate is collected, dried, and calcined for some time at cherry-red heat, with careful stirring. It is raked out while hot into vats of cold water, then levigated and dried. It is zinc oxysulphide. (Griffiths.)

(*b*) A white pigment, said to possess excellent covering properties, is prepared by bringing together barium sulphide and zinc sulphate in solution, and subjecting the precipitate which ensues (a mixture of zinc sulphide and baryta sulphate) to the action of superheated steam, by which, at white heat, all the zinc sulphide will be converted into zinc oxide. (Meissner.)

(*c*) Crude barium sulphide is lixiviated. The supernatant liquid is drawn off, and divided into equal portions. To one, an equivalent of zinc chloride is added, and to this again zinc sulphate, and afterwards another portion of barium sulphide, the result being an intimate mixture of 1 equivalent of barium sulphate and 2 of zinc sulphide. The precipitates, composed of zinc and barium, are collected, pressed to expedite drying, placed in a retort, and brought to a red heat. While still hot, they are drawn into water, preferably cold, which, it seems, has the effect of increasing their density, and imparting body to the paint to be made from them. They are subsequently washed and ground in water to fine powder, or first dried and then ground. By increasing the number of additions of zinc sulphate, the quality may be varied. The pigment thus prepared is used in the ordinary way. (Orr.)

(*d*) Zinc-dust, containing lead, silver, copper, and other impurities, is allowed to digest in leaden vessels filled with a concentrated solution of ammonium carbonate in ammonia water. The ammoniacal zinc solution thus obtained is freed from copper by precipitation with a further small quantity of zinc, decanted off, and submitted to distillation, whereby the ammonia is recovered, and in the retort is found zinc carbonate, which by ignition may be converted into oxide. The residual oxides containing silver and lead may either be treated by the refinery process for the separation of silver, or are washed, dried, ignited to drive off any carbonic acid, and treated with a warm solution of lead acetate. This dissolves the lead oxide present, with formation of a basic acetate, from which lead carbonate is precipitated by treatment with carbonic acid gas. (Schnabel.)

YELLOWS.—*Chrome-yellow.*—(*a*) Add a filtered solution of lead nitrate or acetate to a filtered solution of neutral potash chromate so long as a precipitate falls; collect this, wash with soft water, and dry in security from sulphur-tainted air. (*b*) Dissolve lead acetate in warm water, and add sufficient sulphuric acid to convert it into sulphate; decant the clear liquid, wash the residue with soft water, and digest with agitation in a hot solution of yellow (neutral) potash chromate, containing 1 part of this salt for every 3 lead sulphate; decant the liquid, and drain, wash, and dry the precipitate. (*c*) $\frac{1}{2}$ to $2\frac{1}{2}$ equivalents (according to colour required) sulphuric or phosphoric acid is added to a solution of potash bichromate in water. This mixture is added to a milk of white-lead or litharge (very finely divided and suspended in water), the addition being in the form of a thin stream, to prevent undue heating. The required colouring matter falls. (Werner.) (*d*) Lead chromate is prepared by mixing solutions of a lead salt and potash chromate or bichromate, whereby a precipitate of lead chromate is thrown down. The shade of the precipitate varies from sulphur-yellow to deep orange-red, according to the process of manufacture. The lead salt used may be white sugar of lead, or chloride, prepared by mixing common salt and litharge with water to form a paste, occasionally stirring during the first 24 hours, and allowing to stand until all the oxide has been transformed into chloride. These methods do well on a small scale, but commercially the process is as follows: 4 wooden tubs, about 3 ft. diameter and $1\frac{1}{2}$ ft. high, are arranged one below the other. These are filled with granulated lead, and strong alcohol vinegar is poured into the first. After standing a few minutes, it is drawn off into the next, and so on, until it is finally run into a large collecting tub placed at the bottom of the series. Although the first treatment with vinegar dissolves a very small quantity of the lead, it starts an oxidation on the surface, which the subsequent treatment with the vinegar (which is now allowed to remain an hour in each tub) easily dissolves off, and by this means a moderately strong solution of lead acetate is obtained. A copper pan, with an outside steam-casing, is used for dissolving the charge of potash bichromate, mixed with 10 to 12 times its weight of water. The proper proportion of the solution of acetate is now added, which exactly precipitates the whole of the chromate as lead chromate. The precipitate is allowed to settle. It is then well washed with water by decantation, filtered rapidly, and brought on to boards, where it is allowed to dry slowly. During the drying process, the colour swells up, and care should be taken that this swelling takes place on the boards, and not on the filters. Shades can be obtained from light yellow to dark orange, and almost red. By mixing together some lead bichromate or chromate with the lead acetate solution, a precipitate is obtained of a dark lemon colour; and by mixing caustic alkali with the precipitate on the filter, a much redder shade can be obtained. (*Text. Colourist.*)

Gamboge.—Gamboge is a product of several trees of E. Asia, species of *Garcinia*, natives of Cambodia, the province of Chantibun in Siam, the islands on the E. coast of the Gulf of Siam, the S. parts of Cochin China, the moist forests of Ceylon and S. India, and the southern forests of Travancore and the Tinnevelly

Ghâts. When the rainy season has set in, parties of natives start in search of gamboge-trees, and select those which are sufficiently matured. A spiral incision is made in the bark on two sides of the tree, and joints of bamboo are placed at the base of the incision so as to catch the gum-resin as it exudes with extreme slowness during a period of several months. It issues as a yellowish fluid, but gradually assumes a viscous and finally a solid state in the bamboo receptacle. It is very commonly adulterated with rice-flour and the powdered bark of the tree, but the latter imparts a greenish tint. Sand is occasionally added. The product from a good tree may fill three bamboo joints, each 16 to 20 in. long and 1½ in. in diameter. The trees flourish on both high and low land. Annual tapping is said to shorten their lives, but if the gum-resin is only drawn in alternate years, the trees do not seem to suffer, and last for many years. Dr. Jamie, of Singapore, who has gamboge-trees growing on his estate, says that they flourish most luxuriantly in the dense jungles. He considers the best time for cutting to be February to April. The filled bamboos are rotated near a fire till the moisture in the gamboge has evaporated sufficiently to permit the bamboo to be stripped from the hardened gum-resin. The gamboge is secreted by the tree chiefly in numerous ducts in the middle layer of the bark, besides a little in the dotted vessels of the outermost layer of the wood, and in the pith. It arrives in commerce in the form of cylinders, 4 to 8 in. long and 1 to 2½ in. in diameter, often more or less rendered shapeless. When good, it is dense, homogeneous, brittle, showing conchoidal fracture, scarcely translucent, and of rich brownish-orange colour. Inferior qualities show rough granular fracture and brownish hue, and are sometimes still soft. The pigment consists of a mixture of 15 to 20 per cent. gum with 85 to 80 per cent. resin.

Naples-yellow.—(*a*) Mix 3 lb. powdered metallic antimony, 1 lb. oxide of zinc, and 2 lb. red-lead; calcine, grind fine, and fuse in a closed crucible; grind the fused mass to fine powder, and wash well. (*b*) Grind 1 part washed antimony with 2 parts red-lead to a stiff paste with water, and expose to red heat for 4 to 5 hours.

Orpiment.—Orpiment (arsenic trisulphide) is a lemon or orange-yellow coloured substance, found native in Hungary, the Hartz, and other places; the finest samples used by artists (golden orpiment) come from Persia. The commercial article is artificially prepared for use as a pigment in the following way:—A mixture of arsenious acid and sulphur is placed in an iron subliming-pot, similar to those used in the preparation of crude white arsenic. The mixture is heated until the sublimate, which immediately forms upon the rings fixed above the pot, begins to melt. The proportions of the 2 ingredients used vary largely, the best colours being probably produced when the mixture contains ¼ to ⅕ of sulphur; for the lighter colours, a smaller proportion of sulphur is employed. Orpiment made in this manner consists of a mechanical mixture of arsenic sulphide and oxide. The native sulphide is preferred to the artificial by artists and dyers, by reason of its richer colour.

Realgar.—Realgar (arsenic disulphide) is a deep orange-red substance, soluble in water, and highly volatile and poisonous. It is found native in some volcanic districts, especially in the neighbourhood of Naples; but the commercial article is made by distilling, in earthenware retorts, arsenical pyrites, or a mixture of sulphur and arsenic, or of orpiment and sulphur, or of arsenious acid, sulphur, and charcoal; it has not the brilliant colour of the native mineral, and is much more poisonous. On a large scale, the manufacture is carried on in the following way:—The ingredients are mixed in such proportions that the mixture shall contain 15 per cent. arsenic, and 26 to 28 per cent. sulphur, in order to make allowance for the volatilization of a portion of the latter. The mixture is then placed in earthenware retorts, which are charged every 12 hours with about 60 lb.; this quantity should fill them ¾ full. These are gradually heated to redness for 8 to 12 hours, during which time the realgar distils off, and is collected in earthen receivers, similar to the retorts, but perforated with small holes to permit the escape of these gases. After the operation, the receivers are emptied, and the crude product is re-melted. This is performed in cast-iron pots, the contents being well agitated, and the slag carefully removed. The requisite amount of sulphur or arsenic is added, according to the colour of the mixture, or a proper quantity of realgar containing an excess of the required constituent, and the mass is again stirred. When, on cooling, it exhibits the correct colour and compactness, it is run off into conical moulds of sheet-iron, cooled, and broken up; it is sometimes refined by re-sublimation.

Yellow Lakes.—(*a*) Boil 1 lb. Persian berries, quercitron-bark, or turmeric, and 1 oz. cream of tartar, in 1 gal. water till reduced to half; strain the decoction, and precipitate by solution of alum. (*b*) Boil 1 lb. of the dyestuff with ½ lb. alum in 1 gal. water, and precipitate by solution of potash carbonate. (*c*) Boil 4 oz. annatto and 12 oz. pearlash in 1 gal. water for ½ hour; strain, precipitate by adding 1 lb. alum dissolved in 1 gal. water till it ceases to produce effervescence or a precipitate; strain, and dry.

Paint.—Paint consists essentially of two parts—(1) the vehicle or medium, and (2) the pigment. In the case of oil-paints, a third substance becomes necessary, to facilitate the drying or solidification of the vehicle; this is termed a "drier."

Vehicles.—A perfect vehicle mixes readily with the pigment, forming a mass of about the consistency of treacle. It is colourless, and has no chemical action upon the pigments with which it is mixed. When spread out in a thin layer upon a non-porous substance, it solidifies, and forms a film not liable to subsequent disintegration or decay, and sufficiently elastic to resist a slight concussion. No vehicle complies with all these conditions; those which most nearly approach them are the drying-oils. The use of oil in painting is said to have been invented in the 14th century, and soon reached considerable perfection. Even the best of recent painters have not succeeded in giving to their works that durability which the originators of the method attained. All organic substances are liable to a more or less rapid oxidation, especially if exposed to light and heat. Oil is no exception to this rule; but it seems that, in its pure state, it is much more durable than when mixed with other substances. Although ground-nut- and poppy-oils are sometimes employed by artists where freedom from colour is essential, linseed-oil is the vehicle of by far the larger proportion of paint for both artistic and general purposes.

Oil-paint appears to have been unknown to the ancients, who used various vehicles, chiefly of animal origin. One of these, which was in high repute at Rome, was white-of-egg beaten with twigs of the fig-tree. No doubt the indiarubber contained in the milky juice exuding from the twigs contributed to the elasticity of the film resulting from the drying of this vehicle. Pliny was aware of the fact that when glue is dissolved in vinegar and allowed to dry, it is less soluble than in its original state. Many suggestions have been made in modern times for vehicles in which glue or size plays an important part. In order to render it insoluble, various chemicals have been added to its solution, such as tannin, alum, and a chromic salt. None of these vehicles, however useful for special purposes, has become sufficiently well known to warrant description.

Linseed-oil, to be suitable for painting, must dry well. A test which will indicate whether this be the case or not is to cover a piece of glass with a film of the raw oil, and to expose it to a temperature of about 100° F. (38° C.). The time which the film requires to solidify is a measure of the quality of the oil. If the oil has been extracted from unripe or impure seed, the surface of the test-glass will remain "tacky" or sticky for some time, and the same will happen if the oil under examination has been adulterated with an animal or vegetable non-drying oil.

Until recently, linseed-oil was frequently adulterated with cottonseed-oil, extracted from the waste seeds of the cotton-plant. Where the admixture was considerable, it could easily be detected by the sharp acrid taste of the cottonseed-oil. Now, however, means have been found for removing this disagreeable taste, and the consequence has been that cottonseed-oil is so largely used for adulterating olive-oil, or as a substitute for it, that its price has risen above that of linseed-oil. Another adulterant which is rather difficult to detect is rosin. Oil containing this substance is thick and darker in colour than pure oil. When the proportion of rosin is considerable, its presence may be ascertained by heating a film of the oil upon a metallic plate, when the characteristic smell of burning rosin will be perceptible. When the percentage of rosin is too small for detection in this manner, a film of the oil should be spread upon glass and allowed to dry. When quite hard, the film should be scraped off, and treated with cold turpentine, which will dissolve any rosin which may be present, without materially affecting the oxidized oil. The presence of rosin may also be detected by the following simple chemical test:—The oil is boiled for a few minutes with a small quantity of alcohol (sp. gr. 0·9), and is allowed to stand until the alcohol becomes clear. The supernatant liquid is then poured off, and treated with an alcoholic solution of lead acetate. If the oil be pure, there will be very slight turbidity, while the presence of rosin causes a dense flocculent precipitate. Should linseed-oil be adulterated with a non-drying oil, it will remain sticky for months, when spread out in a thin film upon glass or other non-absorbent substance.

The sp. gr. of linseed oil is in some cases of value in estimating its quality; but as the variations are slight, it would be difficult to detect them in so thick a liquid by means of an ordinary hydrometer. A simple method of obtaining an approximate result is to procure a sample of oil of known good quality, and to colour it with an aniline dye. A drop of this tinted oil will, when placed in the oil to be tested, indicate, by its sinking or swimming, the relative density of the liquid under examination. Freshly-extracted linseed-oil is unfit for making paint. It contains water and organic impurities, respecting the composition of which little is known, and which are generally termed "mucilage." By storing the oil in tanks for a long time, the water and the greater part of the impurities are precipitated, forming at the bottom of the cistern a pasty mass known as "foots."

To accelerate the purification of the oil, and to remove at least a portion of the colouring matter, various methods are in use. The action of sulphuric acid upon linseed-oil is not so favourable as upon other oils. It is, however, sometimes employed, in the proportion of 2 parts of a mixture of equal volumes of commercial sulphuric acid and water to 100 of oil. The dilute acid is poured gradually into the oil, and the mixture is violently agitated for several hours, then run into tanks, and allowed to settle. A concentrated solution of zinc chloride has been substituted for sulphuric acid in the proportion of about 1½ per cent. of the weight of the oil. When the reaction is complete, steam or warm water is admitted into the liquid to clarify it. Oil treated in this way loses a considerable proportion of the colouring matter which it originally contained. When the oil is to be used for white paint, it is sometimes bleached by exposing it to the action of light. On a large scale, this is done in shallow troughs, lined with lead and covered with glass. The lead itself appears to have some influence upon the bleaching of the oil, for the decoloration is not so rapid if the troughs be lined with zinc. For small quantities, a shallow tray of white porcelain gives very good results, the white surface increasing the photo-chemical action. It is not quite clear whether the presence of water accelerates the bleaching of oil by this method; some manufacturers consider its presence necessary, others omit it. Various salts are added to the water, the one most in use being copperas. However the oil may have been prepared, it will, if kept for a long time, deposit a sediment. At first this contains mucilage; but the sediment from old oil consists chiefly of the products of decomposition of the oil itself. Oxygen is not necessary for this decomposition; but it is increased by the action of light. Raw linseed-oil dries more slowly than boiled; but the resulting film is more brilliant and durable. Raw and boiled oils are therefore usually mixed in proportions varying according to the time which can be allowed for the paint to dry, or to the properties required of the film. For ordinary kinds of paint, equal parts of boiled and raw oils are customary. Linseed-oil heated to 350° to 400° F. (176° to 204° C.) dries much more rapidly than in its raw state.

Driers.—The maximum drying power is obtained by the addition of certain metallic oxides, which not only part with some of their own oxygen to the oil, but also act as carriers between the atmospheric oxygen and the heated liquid. This heating of the oil with oxides is known as boiling, although the liquid is not volatilized without decomposition, as is the case with water. At about 500° F. (260° C.), bubbles begin to rise in the oil, producing acrid white fumes on coming into contact with the air. The gas thus given off consists chiefly of vapour of acrolein mingled with carbonic oxide. There is no advantage in heating the oil higher than 350° F. (176° C.; the drying properties of the oil are not increased by heating beyond this point, while its colour is considerably darkened. For the finer qualities of boiled oils, it is essential that the raw oil should have been stored for some time, so that it may be free from mucilage. This mucilage is the chief source of the dark colour of some boiled oils; when heated, it forms a brown substance, which is soluble in the oil itself, and extremely difficult to remove. The oxides usually added to the oil during boiling are litharge or red-lead, the former being preferred on account of its lower price. About 2 to 5 per cent. by weight of the oxides or driers is gradually stirred into the oil after it has been slowly raised to about 300° F. (149° C.). The stirring should be continued until the litharge is dissolved, or it would cake on the bottom of the pan, and cause the oil to burn. Litharge may even be reduced to a cake of metallic lead when the fire is brisk. Some pans are furnished with stirrers and gearing by which the latter can be worked by hand or steam. The material of which the pans are made is wrought- or cast-iron. Copper pans are sometimes used with the object of improving the colour of the oil. Little is known respecting the chemical reactions which take place during the boiling of oil. Even when the air is excluded during the process, the drying properties are greatly increased, and, if boiled long enough, the oil is converted into a solid substance. The loss of weight which ensues is dependent upon the temperature and the time during which the operation continues. It is less when the air is freely admitted than if the pan is covered with a hood. The vapours given off by the oil are of an extremely irritating character, and should be destroyed by passing through a furnace. As their mixture with air in certain proportions is explosive, this furnace should be situated at some distance, and the gases be conducted into it by an earthenware pipe.

Since it has been tried to substitute zinc oxide for white-lead in painting, researches have been made to replace litharge as a drier by a substance free from the inconveniences which caused the abandonment of white-lead. If sulphuretted hydrogen impairs the whiteness of painting done with white-lead, it is not logical to employ a lead drier with zinc paints, because the latter substances will lose their advantage of not becoming dark. Several metallic oxides and salts, especially zinc sulphate, manganese oxide, and umber, have the property of combining with oils, which they render drying. To these may be added the protoxides of the metals of the third class, *i.e.* iron, cobalt, and tin. But these oxides are very unstable and difficult of preparation; hence it became desirable to discover some means by which they might be combined with bodies which would enable them to be prepared cheaply, and at the same time leave unimpaired their desiccating powers. Moreover, it is acknowledged that driers in the dry state are preferable in many respects to drying oils. Following are some of the recently-introduced driers:—

(1) Cobalt and Manganese Benzoates.—Benzoic acid is dissolved in boiling water, the liquid being continually stirred, and neutralized with cobalt carbonate until effervescence ceases. Excess of carbonate is removed by filtration, and the liquor is evaporated to dryness. The salt thus prepared is an amorphous, hard, brownish material, which may be powdered like rosin, and kept in the pulverulent state in any climate, simply folded in paper. Painting executed with a paint composed of 3 parts of this drier with 1000 of oil and 1200 of zinc-white, dries in 18 to 20 hours. Manganese benzoate is prepared in the same way, substituting manganese carbonate for that of cobalt. Applied under similar circumstances, it dries a little more rapidly, and a little less is required. Urobenzoic (hippuric) acid is equally efficacious.

(2) Cobalt and Manganese Borates.—These salts also, in the same proportions, are found to be of equal efficacy. The latter is extremely active, and requires to be used in much smaller proportions.

(3) Resinates.—If an alkaline resinate of potash or soda be dissolved in hot water, and this solution be precipitated by a solution of a proportionate quantity of a cobalt or manganese chloride or sulphate, an amorphous resinate is formed, which, after being collected on cloth filters, washed, and dried, forms an excellent drier.

(4) Zumatic (Transparent) Drier.—Take zinc carbonate, 90 lb.; manganese borate, 10 lb.; linseed-oil, 90 lb. Grind thoroughly, and keep in bladders or tin tubes. The latter are preferable.

(5) Zumatic (Opaque) Drier.—Manganese borate, as a drier, is so energetic that it is proper to reduce its action in the following way:—Take zinc-white, 25 lb.; manganese borate, 1 lb. Mix thoroughly, first by hand, then in a revolving drum; 1 lb. of this mixed with 20 lb. paint ensures rapid drying.

(6) Manganese Oxide.—Purified linseed-oil is boiled for 6 or 8 hours, and to every 100 lb. boiled oil are added 5 lb. of powdered manganese peroxide, which may be kept suspended in a bag, like litharge. The liquid is boiled and stirred for 5 or 6 hours more, and then cooled and filtered. This drying oil is employed in the proportion of 5 to 10 per cent. of the zinc-white.

(7) Guynemer's.—Take pure manganese sulphate, 1 part; manganese acetate, 1 part; calcined zinc sulphate, 1 part; white zinc oxide, 97 parts. Grind the sulphates and acetate to impalpable powder, sift through a metallic sieve. Dust 3 parts of this powder over 97 of zinc oxide, spread out over a slab or board, thoroughly mix, and grind. The resulting white powder, mixed in the proportion of ½ or 1 per cent. with zinc-white, will enormously increase the drying property of this body, which will become dry in 10 or 12 hours.

Grinding.—In working any form of grinding-rollers, great care must be taken to clean them thoroughly immediately after use. If the paint be allowed to dry upon the surface of the rollers, it is difficult of removal, and interferes with the perfect action of the machine. Should the working parts become clogged with solidified oil, a strong solution of caustic soda or potash will remove it. By means of the same solutions, porcelain rollers may be kept quite white, even if used for mixing coloured paints. Although the colour of most pigments is improved by grinding them finely in oil, there are some which suffer in intensity when their size of grain is reduced. Chrome red, for instance, owes its deep colour to the crystals of which it is composed, and when these are reduced to extremely fine fragments, the colour is considerably modified.

Storing.—When paint is not intended for immediate use, it is packed in metallic kegs. For exportation to hot climates, the rim of the lid is soldered down, a practice which effectually prevents access of atmospheric oxygen. White-lead paint is frequently packed in wooden kegs; these prevent the discoloration sometimes caused by iron kegs. When paint is mixed ready for use, it will, if exposed to the air, become covered with a skin, which soon attains sufficient thickness to exclude atmospheric oxygen, and prevent any further solidification of the oil. The paint may be still better protected by pouring water over it, or it may be placed in air-tight cans. If it has been allowed to stand for some time, it must be well stirred before using, as the pigments have a tendency not only to separate from the oil, but also to settle down according to their specific gravity.

Applying.—Of whatever nature the surface may be to which the paint is to be applied, great care must be taken that it is perfectly dry. Wood especially, even when apparently dry, may on a damp day contain as much as 20 per cent. of moisture. A film of paint applied to the surface of wood in this condition prevents the moisture from escaping, and it remains enclosed until a warm sun or artificial heat converts it into vapour, which raises the paint and causes blisters. Moisture enclosed between two coats of paint has the same effect. Paint rarely blisters when applied to wood from which old paint has been burnt off; this is probably due to the drying of the wood during the operation of burning.

Priming.—The first coat of paint applied to any surface is termed the "priming-coat." It usually consists of red-lead and boiled and raw linseed-oil. Experience has shown that such a priming not only dries quickly itself, but also accelerates the drying of the next coat. The latter action must be attributed to the oxygen contained in the red-lead, only a small portion of which is absorbed by the oil with which it is mixed. Kall, of Heidelberg, prepares a substitute for boiled oil by mixing 10 parts whipped blood, just as it is furnished from the slaughter-houses, with 1 part of air-slaked lime sifted into it through a fine sieve. The two are well mixed, and left standing for 24 hours. The dirty portion that collects on top is taken off, and the solid portion is broken loose from the lime at the bottom; the latter is stirred up with water, left to settle, and the water poured off after the lime has settled. The clear liquid is well mixed up with the solid substance before mentioned. This mass is left standing for 10 or 12 days, after which a solution of potash permanganate is added, which decolorizes it and prevents putrefaction. Finally the mixture is stirred up, diluted with more water to give it the consistence of very thin size, filtered, a few drops of oil of lavender added, and the preparation preserved in closed vessels. It is said to keep a long time without change. A single coat of this liquid will suffice to prepare wood or paper, as well as lime or hard plaster walls, for painting with oil colours. This substance is cheaper than linseed-oil, and closes the pores of the surface so perfectly that it takes much less paint to cover it than when primed with oil.

Drying.—The drying of paint is to a great extent dependent upon the temperature. Below the freezing-point of water, paint will remain wet for weeks, even when mixed with a considerable proportion of driers; while, if exposed to a heat of 120° F. (49° C.), the same paint will become solid in a few hours. The drying of paint being a process of oxidation and not evaporation, it is essential that a good supply of fresh air should be provided. When a film of fresh paint is placed with air in a closed vessel, it does not absorb the whole of the oxygen present; but after a time the drying process is arrested, and the remaining oxygen appears to have become inert. Considerable quantities of volatile vapours are given off during the drying of paint; these are due to the decomposition of the oil. When the paint has been thinned down by turpentine, the whole of this liquid evaporates on exposure to the air. There must, therefore, be a plentiful access of air, to remove the vapours formed, and afford a fresh supply of active oxygen. The presence of moisture in the air is rather beneficial than injurious at this stage. Especially in the case of paints mixed with varnish, moist air appears to counteract the tendency to crack or shrink. Under the erroneous impression that the drying of paint is a species of evaporation, open fires are sometimes kept up in freshly-painted rooms. It is only when the temperature is very low that any benefit can result from this practice: as a rule, it rather retards than hastens the solidification of the oil, which cannot take place rapidly in an atmosphere laden with carbonic acid. The first coat of paint should be thoroughly dry before the second is applied. Acrylic acid is formed during the oxidation of linseed-oil, and unless this be allowed to evaporate, it may subsequently liberate carbonic acid from the white-lead present in most paints, and give rise to blisters. Sometimes a second priming-coat is given; but usually the second coat applied contains the pigment. This, as soon as dry, is again covered by another coat, and subsequently by two or more finishing-coats, according to the nature of the work.

Filling.—Before the first coat is applied to wood, all holes should be filled up. The filling usually employed is ordinary putty; this, however, sometimes consists of whiting ground up with oil foots of a non-drying character, and when the films of paint are dry, the oil from the putty exudes to the surface, causing a stain. The best filling for ordinary purposes is whiting ground to a paste with boiled linseed-oil. For finer work, and for filling cracks, red-lead mixed with the same vehicle may be employed. For porous hard woods, use boiled oil and corn starch stirred into a very thick paste; add a little japan, and reduce with turpentine. Add no colour for light ash; for dark ash and chestnut, use a little raw sienna; for walnut, burnt umber and a slight amount of Venetian red; for bay wood, burnt sienna. In no case use more colour than is required to overcome the white appearance of the starch, unless you wish to stain the wood. This filler is worked with brush and rags in the usual manner. Let it dry 48 hours, or until it is in condition to rub down with No. 0 sandpaper, without much gumming up; and if an extra fine finish is desired, fill again with the same materials, using less oil, but more japan and turpentine. The second coat will not shrink, being supported by the first. When the second coat is hard, the wood is ready for finishing up by following the usual methods. This formula is not intended for rosewood.

Coats.—There is no advantage in laying on the paint too thickly. A thick film takes longer to dry thoroughly than two thin films of the same aggregate thickness. Paint is thinned down or diluted with linseed-oil or turpentine. The latter liquid, when used in excess, causes the paint to dry with a dull surface, and has an injurious effect upon its stability. Sometimes the last coat of paint is mixed with varnish, in order to give it greater brilliancy. In this case, special care must be taken that the previous coats have thoroughly solidified, or cracks in the final coat may subsequently appear. The same remark applies when the surface of the paint is varnished. The turpentine with which the varnish is mixed has a powerful action upon the oil contained in the paint, if the latter is not thoroughly oxidized. The exterior of the paint is thus softened, and the varnish is enabled to shrink and crack, especially in warm weather.

Brushes.—The bristles are frequently fastened by glue or size, which is not perceptibly acted upon by oil, and if brought into contact with this liquid alone, there would be no complaints of loose hairs coming out and spoiling the work. It is a common practice to leave the brushes in a paint-pot, in which the paint is covered with water to keep it from drying. The brushes are certainly kept soft and pliant in this way; but at the same time the glue is softened, and the bristles come out as soon as the brush is used. After use, brushes should be cleaned, and placed in linseed-oil until again required, when they will be found in good condition. Treated in this way, they will wear so much better that the little additional trouble entailed is amply repaid. When brushes will not again be required for some time, the oil remaining in them should be washed out by means of turpentine, after which they may be dried without deterioration. On no account should oil be allowed to dry in a brush, as it is most difficult to remove after oxidation has taken place. The best means are steeping in benzoline for a few days, or in turpentine, with occasional washing in soda-water and with soft-soap, avoiding too violent rubbing.

Surface.—When the surface to be painted is already covered with old paint, this should be either removed or rubbed down smooth before applying the new. When the thickness of the old coat is not great, rubbing down, accompanied by a careful scraping of blisters and defective parts, will suffice. When the thickness of the old paint necessitates its removal, it may either be burnt off, or softened by a solution of caustic alkali, and afterwards scraped. The burning process is the most effective, and leaves the wood in a fit condition to receive the fresh coat of paint; but it is not applicable in the case of fine mouldings. When caustic potash or soda is used, the paint is left in contact with it for some time, when the linoleic acid of the oxidized linseed-oil becomes saponified, and can easily be scraped or scrubbed off the surface of the wood. Whenever an alkali is employed, it is of the greatest importance that the wood should afterwards be thoroughly washed several times with clean water, in order to remove every trace of the solvents. Any soda or potash remaining in the pores of the wood would not only retain moisture and cause blistering, but would also have an injurious action upon the vehicle of the paint subsequently applied, and in many cases upon the pigment itself. The remarks already made as to the necessity of an absolutely dry surface should be borne in mind in this instance. When the surface of the paint is to be protected by a coat of varnish, the latter should not be applied until the whole of the oil contained in the paint has solidified. The wrinkling of varnish upon paint is frequently erroneously attributed to the bad quality of the varnish, when the real cause is the incomplete oxidation of the paint itself.

Water-colours.—The manufacture of water-colour paints is more simple than that of oil-paints, the pigments being first ground extremely fine and then mixed with a solution of gum or glue. The paste produced in this manner is allowed to dry, after having been stamped into the form of cakes. As soon as the hardened mass is rubbed down with water, the gum softens and dissolves, and if the proportion of water be not too great, the pigment will remain suspended in the solution of gum, and can be applied in the same manner as oil-paint. To facilitate the mixing with water, glycerine is sometimes added to the cake of paint, which then remains moist and soft.

Removing Smell.—(1) Place a vessel of lighted charcoal in the room, and throw on it 2 or 3 handfuls of juniper berries; shut the windows, the chimney, and the door close; 24 hours afterwards the room may be opened, when it will be found that the sickly, unwholesome smell will be entirely gone. (2) Plunge a handful of hay into a pail of water, and let it stand in the room newly painted.

Discoloration. — Light - coloured paints, especially those having white-lead as a basis, rapidly discolour under different circumstances. Thus white paint discolours when excluded from the light; stone colours lose their tone when exposed to sulphuretted hydrogen, even when that is only present in very small quantity in the air; greens fade or darken, and vermilion loses its brilliancy rapidly in a smoky atmosphere like that of London. Ludersdorf thinks that the destructive change is principally due to a property in linseed oil which cannot be destroyed. The utility of drying oils for mixing pigments depends entirely on the fact that they are converted by the absorption of oxygen into a kind of resin, which retains the colouring pigment in its semblance; but during this oxidization of the oil—the drying of the paint—a process is set up which, especially in the absence of light and air, soon gives the whitest paint a yellow tinge. Ludersdorf therefore proposes to employ an already formed but colourless resin as the binding material of the paint, and he selects two resins as being specially suitable—one, sandarach, soluble in alcohol; the other, dammar, soluble in turpentine. The sandarach must be carefully picked over, and 7 oz. is added to 2 oz. Venice turpentine and 24 oz. alcohol of sp. gr. 0·833. The mixture is put in a suitable vessel over a slow fire or spirit-lamp, and heated, stirring diligently, until it is almost boiling. If the mixture be kept at this temperature, with frequent stirring, for an hour, the resin will be dissolved, and the varnish is ready for use as soon as cool. The Venice turpentine is necessary to prevent too rapid drying, and more dilute alcohol cannot be employed, because sandarach does not dissolve easily in weaker alcohol, and, furthermore, the alcohol, by evaporation, would soon become so weak that the resin would be precipitated as a powder. When this is to be mixed with white-lead, the latter must first be finely ground in water, and dried again. It is then rubbed with a little turpentine on a slab, no more turpentine being taken than is absolutely necessary to enable it to be worked with the muller; 1 lb. of the white-lead is then mixed with exactly ½ lb. of varnish, and stirred up for use. It must be applied rapidly, because it dries so quickly. If when dry the colour is wanting in lustre, it indicates the use of too much varnish In such cases, the article painted should be rubbed, when perfectly dry, with a woollen cloth to give it a gloss. The dammar varnish is made by heating 8 oz. dammar in 16 oz. turpentine oil at 165° to 190° F. (74° to 88° C.), stirring diligently, and keeping it at this temperature until all is dissolved, which requires about an hour. The varnish is then decanted from any impurities, and preserved for use. The second coat of the pure varnish, to which half its weight of oil of turpentine has been added, may be applied. It is still better to apply a coat of sandarach varnish made with alcohol, because dammar varnish alone does not possess the hardness of sandarach, and when the article covered with it is handled much, does not last so long.

Miscellaneous Paints.—Under this head the following few varieties deserve notice:—

Cement Paint for Carton-pierre.—Composed of 2 parts washed graphite, 2 red-lead, 16 freshly-prepared cement, 16 barium sulphate, 4 lead protoxide, 2 alcoholized white litharge. The paint must be put on as soon as the roofing is securely fastened, choosing the dry season and a sunny day. Care must be taken to put it on well over the joints; it is recommended that an extra coating should be given to the portions that overlap each other, so as to render them watertight. As a rule, two coats are put on. The first, whilst still wet, is covered with an even layer of fine dry sand sprinkled over it through a sieve. This is done bit by bit, as the roof is painted, so as to prevent the workmen stepping on the wet paint. The second coat is put on about a week later, the sand which has not stuck fast being first swept off. The second coat is not sanded. It is merely intended to combine with the under-coat and form a durable waterproof surface, which will prevent the evaporation of the tar-oil, the usual cause of the failure of carton-pierre roofing, and present a good appearance as well. (Mack.)

Copper paint. — Bessemer's copper paint gives a glossy and elegant covering to metal, wood, or porcelain; when united with oils, it assumes an antique green appearance.

Gold paint.—Do not mix the gold size and powder together, but go over the article to be gilded with the size alone, giving an even and moderate coating. Let it dry (which will not take long) till it is just sticky, or, as gilders call it, "tacky." Then over a sheet of smooth writing-paper dust on the dry gold powder by means of a stout, soft, sable brush.

Iron paint.—The 'Photographisches Wochenblatt' mentions that Spangenberger has a paint composed of pulverized iron and linseed-oil varnish. It is intended for painting damp walls, kettles, outer walls, or any place or vessel exposed to the action of the open air and weather. Should the article be exposed to frequent changes of temperature, linseed-oil varnish and amber varnish should be mixed with the paint intended for the first 2 coats, without the addition of any artificial drying medium. The first coat should be applied rather thin, the second a little thicker, and the last in a rather fluid state. It is not necessary to free iron from rust, grease, &c., by means of acid before applying the paint, as a superficial cleaning is sufficient. The paint is equally adapted as a weather-proof coating for iron, wood, and stone.

Lime paints.—(*a*) For deal floors, wood, stone, and brick work. Dissolve 15 dr. good glue by boiling with thickish milk of lime, which contains 1 lb. caustic lime. Then add linseed-oil, just sufficient to form a soap with the lime. This mixture can be used for making up any colour which is not altered by lime. A solution of shellac in borax can be added for brown-red or brown-yellow colours, and is very suitable in painting deal floors. With a coating of varnish or lake, the substances thus painted assume a fine lustre. They can be polished with linseed-oil or turpentine.

(*b*) A lime paint which will bear washing. 3 parts flint, 3 marble fragments and sandstone, 2 calcined white china-clay, and 2 slaked lime, all in powder, furnish a paint to which chosen colours, that may be employed with lime, are added. This paint, by repeated applications, becomes as hard as stone, without losing porosity.

Silicated.—When the surface to be painted is of a mineral nature, such as the exterior of a house, the pigments may be mixed with a vehicle consisting chiefly of water-glass, or soda or potash silicate. This method of painting requires some care, and a knowledge of the chemical nature of the pigments used. Some colours are completely destroyed by the alkali contained in the water-glass. Among those pigments which are not altered by the alkali may be mentioned lime carbonate, baryta-white, zinc-white, cadmium-yellow, Naples-yellow, baryta chromate, chrome-red, red ultramarine, blue ultramarine, cobalt-blue, cobalt-green, chrome-green, ivory-black. When a wall is to be painted, it should first be prepared with a mortar composed of pure fat lime and clean sharp sand. The water used should also be free from saline impurities, as these might subsequently effloresce and destroy the surface of the paint. When the surface of this plaster is dry, a weak solution of water-glass should be applied, and the operation repeated several times. A strong solution cannot be used, because it forms a thin skin on the surface of the plaster, which closes the pores, and prevents the penetration of the water-glass. The pigments are rubbed down with a very weak solution of water-glass, and applied in the ordinary manner. When thoroughly dry, the painted surface is treated with a warm solution of potash silicate applied in the form of a spray. Soda silicate may also be used, but the soda carbonate which is then formed is liable to cause efflorescence. A pigment fixed on the surface of a wall in this manner is as durable as the wall itself, and can be exposed to the weather without any fear of deterioration.

Steatite paint.—In the United States this is made from a native hydrated magnesia silicate, and is applied to ships' bottoms, to walls for preventing dampness, and to roofs for making them fireproof.

Transparent paints.—If in a position to coat the glass before putting in frame, excellent effects may be got by using ordinary shellac varnish (made with bleached shellac) tinted with aniline dye. The glass must be slightly warmed before applying the varnish. The strongest spirit of wine should be used for dissolving the shellac and the powdered (not liquid) aniline colours. Sufficient of the colour must be added to the varnish to give the required tint: 1 part of shellac to 8 of spirit is a good proportion. Methylated spirit will do. The varnish should be poured on and placed evenly over the glass (not painted on), and the superfluous quantity returned to the bottle.

Tungsten paints.—The mineral colours from tungsten are obtained by decomposing soluble tungstates by means of salts of the metals yielding insoluble phosphates. The tungstate of nickel produces a light green, tungstate of chromium a dark grey, tungstate of cobalt a violet or indigo blue, and tungstate of barium a bright white colour. Tungstic acid alone gives a fine light greenish-yellow. All these colours may be employed for water- or oil-colour paints; the last is a really desirable and probably quite unchangeable colour.

Window paint.—Mix with white lead, boiled oil or varnish, and a small quantity of driers (no turps, which hardens for the time, being a volatile oil, and therefore objectionable in this case); paint this over the glass thinly, and stipple it. If you have not a proper brush, make a large pledget of cotton wool or tow, cover it with a clean bit of linen rag, and quickly dab it over the paint.

Zinc paint.—The difficulty of making oil colours adhere to zinc is well known. Some time since, Prof. Böttger published a process which consists in applying with a hard brush a mordant composed of 1 part copper chloride, 1 copper nitrate, 1 sal-ammoniac, and 64 water, to which is added afterwards 1 hydrochloric acid. The zinc immediately becomes intensely black, which changes in drying (12 to 24 hours) to a dirty whitish grey, on which oil colours may be laid, and to which they will adhere firmly.

Painting.—The composition of paints should be governed—(1) by the nature of the material to be painted: thus the paints respectively best adapted for wood and iron differ considerably; (2) by the kind of surface to be covered—a porous surface requires more oil than one that is impervious; (3) by the nature and appearance of the work to be done: delicate tints require colourless oil, a flatted surface must be painted without oil (which gives gloss to a shining surface), paint for surfaces intended to be varnished must contain a minimum of oil; (4) by the climate and the degree of exposure to which the work will be subjected: for outside work, boiled oil is used, because it weathers better than raw oil. turps is avoided as much as possible, because it evaporates and does not last; if, however, the work is to be exposed to the sun, turps is necessary to prevent the paint from blistering; (5) the skill of the painter affects the composition; a good workman can lay on even coats with a smaller quantity of oil and turps than one who is unskilful; extra turps, especially, are often added to save labour; (6) the quality of the materials makes an important difference in the proportions used: thus more oil and turps will combine with pure than with impure white lead; thick oil must be used in greater quantity than thin; when paint is purchased ready ground in oil, a soft paste will require less turps and oil for thinning than a thick; (7) the different coats of paint vary in their composition: the first coat laid on to new work requires a good deal of oil to soak into the material; on old work, the first coat requires turpentine to make it adhere; the intermediate coats contain a proportion of turpentine to make them work smoothly; and to the final coats the colouring materials are added, the remainder of the ingredients being varied according as the surface is to be glossy or flat.

The exact proportions of ingredients best to be used in mixing paints vary according to their quality, the nature of the work required, the climate, and other considerations. The composition of paint for different coats also varies considerably. The proportions given in the following table must only be taken as an approximate guide when the materials are of good quality:—

TABLE showing the COMPOSITION of the different COATS of WHITE PAINT, and the QUANTITIES required to cover 100 yd. of NEWLY-WORKED PINE.

	Red-lead.	White-lead.	Raw Linseed-oil	Boiled Linseed-oil.	Turpentine.	Driers.	REMARKS.
Inside work, 4 coats not flatted.	lb.	lb.	pt.			lb.	
Priming	½	16	6	—	—	¼	Sometimes more red-lead is used and less drier.
2nd coat	*	15	3½	—	1½	¼	* Sometimes just enough red-lead is used to give a flesh-coloured tint.
3rd coat	—	13	2½	—	1½	¼	
4th coat	—	13	2½	—	1½	¼	
Inside work, 4 coats and flatting.							
Priming	1½	16	6	—	½	1–8	
2nd coat	—	12	4	—	1½	1–10	
3rd coat	—	12	4	—	0	1–10	
4th coat	—	12	4	—	0	1–10	
Flatting	—	9	0	—	3½	1–10	
Outside work, 4 coats not flatted.							When the finished colour is not to be pure white, it is better to have nearly all the oil boiled oil. All boiled oil does not work well. For pure white, a larger proportion of raw oil is necessary, because boiled oil is too dark.
Priming	2	18½	2	2	—	1–8	
2nd coat	—	15	2	2	½	1–10	
3rd coat	—	15	2	2	½	1–10	
4th coat	—	15	3	2½	0	1–10	

For every 100 sq. yd., besides the materials enumerated in the foregoing, 2½ lb. white-lead and 5 lb. putty will be required for stopping. The area which a given quantity of paint will cover depends upon the nature of the surface to which it is applied, the proportion of the ingredients, and the state of the weather. When the work is required to dry quickly, more turpentine is added to all the coats. In repainting old work, two coats are generally required, the old paint being considered as priming. Sometimes another coat may be deemed necessary. For outside old work exposed to the sun, both coats should contain 1 pint turpentine and 4 pints boiled oil, the remaining ingredients being as stated in the foregoing table. The extra-turpentine is used to prevent blistering. In cold weather, more turpentine should be used to make the paint flow freely.

Surface painting is measured by the superficial yd., girting every part of the work covered, always making allowance for the deep cuttings in mouldings, carved work, railings or other work that is difficult to get at. Where work is very high, and scaffolding or ladders have to be employed, allowances must be made. The following rules are generally adopted in America in the measurement of work:—Surfaces under 6 in. in width or girt are called 6 in.; from 6 to 12 in., 12 in.; over 12 in., measured superficial. Openings are deducted, but all jambs, reveals, or casings are measured girt. Sashes are measured solid if more than two lights. Doors, shutters and paneling are measured by the girt, running the tape in all quirks, angles or corners. Sash doors measure solid. Glazing in both windows and doors is always extra. The tape should be run close in over the battens, on batten doors, and if the stuff is beaded, add 1 in. in width for each bead. Venetian blinds are measured double. Dentels, brackets, medallions, ornamented iron work, balusters, lattice work, palings, or turned work, should all be measured double. Changing colours on base boards, panels, cornices, or other work, one-fourth extra measurement should be allowed for each tint. Add 5 per cent. to regular price for knotting, puttying, cleaning, and sandpapering. For work done above the ground floor, charge as follows:—Add 5 per cent. for each storey of 12 ft. or less, if interior work; if exterior work, add 1 per cent. for each ft. of height above the first 12 ft.

Carriage-Painting.—The following is the substance of an address delivered by McKeon, secretary and treasurer of the Master Car-Painters' Association, of the United States:—A first-class railway coach costs, when complete, about 1200*l.* To protect this work, the painter expends 60*l.* to 120*l.* The latter figure will make a first-class job. The car has been completed in the wood-shop, and is turned over to the painter, who is responsible for the finish. He is expected to smooth over all rough places or defects in the wood, which requires both patience and skill to make the work look well. Twelve weeks should be the time allowed to paint a car, and it cannot be done in any less time, to make a good job that will be a credit to the painter and all other parties interested in the construction and finish of the car. Too much painting is done in a hurry; proper time is not given the work to dry or become thoroughly hardened before it is run out of the shop, and consequently it does not always give the satisfaction it should; nor can it be expected that hurried work will be so lasting or durable as that which has the necessary time given to finish it.

Priming Paint.—The priming coat of paint on a car is of as much importance as any succeeding one, and perhaps more. Good work is ruined in the priming by little or no attention being given by the painter to the mixing and application of the first coat. The foundation is the support, and on that rests success or failure. The priming should be made of the proper material, mixed with care from good lead and good oil, and not picked up from old paints, which have been standing mixed, and must necessarily be fat and gummy, for such are unfit for use on a good job, and will have a decided tendency to spoil the whole work. Special care should be exercised, both in mixing and applying the priming, and it should be put on very light, so that it may penetrate well into the wood. Too much oil is worse than not enough. Good ground lead is by far the best material for the under-coats on a car. Two coats should be given to the car before it is puttied, as it is best to fill well with paint the nail-holes and plugs, as well as defects in the wood, so that moisture may not secure a lodgment, which otherwise will cause the putty to swell, although sometimes unseasoned lumber will swell the putty; and as it shrinks, the nail remains stationary, and of course the putty must give way.

Best Putty.—In mixing putty, which may be a small matter with some, take care to so prepare it that it will dry perfectly hard in 18 hours. Use ground lead and japan, stiffening up with dry lead, and whatever colouring you may require in it to match your priming coats.

The next coats, after the work is well puttied, should be made to dry flat and hard. Two coats should be applied, and, for all ordinary jobs or cheap work, sandpapering is all that is necessary for each coat; but when a good surface is required, I would recommend one coat to be put on heavy enough to fill the grain; and before being set, scrape with a steel scraper. The plain surface is all that requires coating and scraping with the heavy mixture. For this coat, which is called filling, use one half ground lead and any good mineral which experience has shown can be relied on. This scraping of the panel work will fill the wood equal to two coats of rough-stuff, and saves a great amount of labour over the old process, when so much rubbing with lump pumice was done. Sandpaper when the filling is thoroughly hard, and apply another coat of paint of ordinary thickness, when, after another sandpapering, you have a good surface for your colour.

Rough-coating on cars has gone almost out of use, and few shops are now using it to any extent. My experience is that paint has less tendency to crack where rough-stuff is left off. I do not claim that the filling was the principal cause of the cracking, if it was properly mixed; but I believe the water used in rubbing down a car with the lump pumice injures the paint, as it will penetrate in some places, particularly around the moulding plugs.

Finishing Colour.—The car being ready for the finishing colour, this should be mixed with the same proportion of drier as the previous coat, or just sufficient to have it dry in about the same time. A great error with many car-painters is using a large portion of oil in the under-coats, and then but little, if any, in the finishing coats: this has a decided tendency to crack, the under-coats being more elastic. Always aim to have colour dry in about the same time, after you have done your priming; by this plan you secure what all painters should labour to accomplish—namely, little liability to crack. Work will of course crack sometimes, after being out a few months, or when it has repeated coatings of varnish; and using a quick rubbing-varnish on work will cause it to give way in fine checks quicker than anything else. Many of the varnishes used are the cause of the paint cracking, and no painter has been wholly exempt from this trouble.

Cause of Cracking.—The most common cause of cracking is poor japan, which is the worst enemy that the car-painter has to contend with. The greater part of the japan is too elastic, and will dry with a tack, and the japan gold size has generally the same fault, although the English gold size is generally of good quality; but its high price is an objection to its use. A little more care in the manufacture of japans would give a better drier, and few would object to the additional cost. Japan frequently curdles in the paint; it will not mix with it, but gathers in small gummy particles on the top. Work painted with such material cannot do otherwise than crack and scale, and the remedy lies only in getting a good pure article of turpentine japan.

In regard to using ground lead, car-painters differ, as some prefer to grind their own in the shop. I use the manufactured lead, and my reasons for doing so are that it is generally finer than any shop can grind it with present facilities, and it has age after grinding, which improves its quality. You can also get a purer lead and one with more body than you can by grinding in the shop, which is a fact that I think most painters must admit. I have tested it very fully, and am convinced on this point.

Mixing the Paints.—Permit me to make a few suggestions here in regard to the mixing of paint, which may not fully agree with others' views. There is just as much paint that cracks by putting it on too flat as by using too much oil. Some painters mix their finishing colour so that it is impossible to get over a panel of ordinary size before it is set under the brush, and consequently the colour will rough up. Colour should be mixed up so that it will not flat down for some time after leaving it, and then you have got some substance that will not absorb the varnish as fast as it is applied to the surface. This quick drying of colour is not always caused by want of oil in it, but because there is too much japan, and a less quantity of the latter will do better work, and make a smoother finish. Give your colour 48 hours to dry between coats; always give that time, unless it is a hurried job, and experience has fully demonstrated that it is poor economy to hurry work out of the shop before it is properly finished.

Oils, Driers, and Colours.—In car-painting, both raw and boiled oils are used, and good work may be done with either, but I recommend oil that is but slightly boiled, in preference to either the raw or the boiled. After it is boiled, if it is done in the shop, let it stand 24 hours to settle, then strain off carefully; this takes out all the impurities and fatty matter from the oil, and it will dry much better, nor will it have that tack after drying that you find with common boiled oil. Use the proper quantity of drier in mixing your paint, and a good reliable job will be the result. In car-painting, never use prepared colours which are ground in oil, as nine-tenths of such colours are ground in a very inferior oil, and they may have been put up for a great length of time, in which case they become fatty, and will invariably crack. These canned colours do not improve with age, as lead and varnish do. Finishing colours should all be ground in the shop, unless special arrangements can be made with manufacturers to prepare them; and the colour should be fresh, not over 6 or 8 days old after being mixed and open to the air. Enough may be prepared at a time to complete the coating on a job; but when colour stands over a week, it is not fit to use on first-class work, as it becomes lifeless, and has lost that free working which we find in freshly mixed colours. Such colour may, however, be used upon a cheap class of work, or on trucks, steps, &c., so that nothing need be wasted in the shop.

Varnishing.—Three coats of varnish over the colour are necessary on a first-class coach. The first coat should be a hard drying varnish put on the flat colour; the quick rubbing that some use I would not recommend, but one that will dry in 5 days (in good drying weather) sufficiently hard to rub, is the best for durability. After striping and ornamenting the car, and when thoroughly washed, give a coat of medium drying varnish. Let this stand 8 days; then rub lightly with curled hair or fine pumice, and apply the finishing coat, which is "wearing body;" this will dry hard in about 10 days, after which the car may be run out of the shop. It should then be washed with cold water and a soft brush, and is ready for the road. In varnishing, many will apply the varnish as heavy as they can possibly make it lie, when, as a consequence, it flows over and runs or sags down in ridges, and of course does not harden properly; this also leaves a substance for the weather to act on. It is better to get just enough on at a coat to make a good even coating which will flow out smooth, and this will dry hard, and will certainly wear better than the coat that is piled on heavily.

Varnishing, we claim, can be overdone, some painters' opinions to the contrary. We have heard of those who put 2½ gal. on the body of a fifty-foot car at one application, and we have also listened to the declaration, made by a member of the craft, that he put 2 gal. on the body of a locomotive tank. Such things are perhaps possible, and may have been done; but if so, we know that the work never stood as well as it would if done with one-half the quantity to a coat. In varnishing a car, care should be taken to have the surface clean; water never injures paint where it is used for washing; and a proper attention to cleanliness in this respect, and in the care of brushes used for varnishing, will ensure a good-looking job.

Perhaps your shop facilities for doing work are none of the best, but do the best you can with what you have. Select, if possible, a still, dry day for varnishing, especially for the finishing coat. Keep your shop at an even temperature; avoid cold drafts on the car from doors and windows; wet the floor only just sufficient to lay the dust, for if too wet, the dampness arising will have a tendency to destroy the lustre of your varnish. Of course we cannot always do varnishing to our perfect satisfaction, especially where there are 25 or 30 men at work in an open shop, and 6 or 8 cars are being painted, when more or less dirt and dust are sure to get on the work.

A suggestion might here be made to railroad managers, which is that no paint-shop is complete where the entire process of painting and finishing a car is to be done in one open shop. A paint-shop should be made to shut off in sections by sliding doors, one part of the shop being used exclusively for striping and varnishing. I know from experience that nine-tenths of the railroad paint-shops are deficient in this particular, and still we are expected to turn out a clean job, no matter what difficulties we are compelled to labour under. Many further hints might be given in regard to this matter of shop facilities and conveniences; but as it is not here my object to argue the point, I leave it with this brief mention.

Importance of Washing Vehicles.—In regard to the care of a car after it has left the shop, more attention should be given to this than is done on many roads. The car should not be allowed to run until it is past remedy, and the dirt and smoke become imbedded in the varnish, actually forming a part of the coating, so that when you undertake to clean the car you must use soda or soap strong enough to cut the varnish before you succeed in removing the dirt. Cars should be washed well with a brush and water at the end of every trip. This only will obviate the difficulty, and these repeated washings will harden the varnish as well as increase its lustre. We know that, in washing a car, where soap is required to remove the dirt and smoke, it is almost impossible to get the smoke washed off clean; and if it is not quite impossible, the hot sun and rain will act on the varnish and very soon destroy it.

Re-varnishing.—Cars should be taken in and re-varnished at least once in 12 months; and if done once in 8 months, it is better for them, and they will require only one coat; but where they run a year, they will generally need two coats. Those varnished during the hot months will not stand as well as if done at any other time. Painting done in extremely cold weather, or in a cold shop, is more liable to crack than if done in warm weather.

How to Dry Paint.—Paint dried in the shop, where there is a draught of dry air passing through, will stand better than that dried by artificial heat; and you will find, by giving it your attention, that work which has failed to stand, and which cracked or scaled, was invariably painted in the winter season or in damp, wet weather. I have paid some attention to this matter, and know the result.

Woodwork Painting.—One of the attendant drawbacks of houses that are newly built, or have been hastily finished for letting, is the inferior painting of the woodwork, and its speedy destruction. The wood is not thoroughly dry, and the consequence is the preparatory coat does not adhere; the pores being full of dampness, it is impossible for the oil to sink into them, especially as oil and water are unmiscible. Another equally injurious condition is the gum-resin which exudes from the knots of new pine and other timber. Painted over before it has time to come to the surface, the coat is destroyed by the action of the gum. Now, these evils have to be endured so long as the wood has no time to get seasoned. The painter follows the carpenter without any interval of time, and before the action of the weather can bring out the moisture and resinous substances. A coating of shellac is usually given to the knots, though this is often so thin as to be worthless. Crude petroleum, as a preservative coat, is found to be an admirable preparation for the painting. The petroleum is thin, and penetrates the wood, filling up the pores, and giving a good ground for the coats of paint. According to one American authority, the preparation is of great value. The priming coat should be thin and well rubbed in, and it is better to use a darker colour than white-lead as a base. White-lead forms a dense covering to the surface, though it has its disadvantages. When petroleum has formed the first coat, two other coats will suffice, one being the priming coat, and a third coat may be given after the work has stood for a season. It is a very desirable plan to leave the painting, or rather finishing coats, for a time, so that any imperfections in the wood or work may be discovered; it also allows time for any change of colour that may be made. After the priming coat, it is usual in good work to stop all cracks, nail-holes, and other defects with putty; but in the commoner class of paintings, the coats are laid on quickly; the preceding coat has hardly time to dry before the next is put on, and all the defects of wood, bad seasoning, exudation of gum, &c., quickly begin to show themselves through and disfigure the work. A good paint ought to possess body power of covering up, of flowing evenly from the brush, and become hard. Though zinc-white has less body than white-lead, it is more durable, and will stand sulphur acids without blackening. Some colours stand better than others; the ochres, Indian and Venetian reds, burnt and raw umber are reliable, and may be used without scruple. It is also worthy of notice that salt air acts injuriously on white-lead, and zinc-white is therefore preferable in situations exposed to the sea-air. (*Eng. Mech.*)

POTASSIUM OXALATE.—The rapid dry-plate processes in photography, which are at present exciting considerable attention among the more advanced classes of those engaged in the art, have created a demand for neutral potassium oxalate that cannot be supplied through the ordinary trade channels. The preparation is simple, involving no special apparatus. There are three oxalates of potassium known to chemists—the neutral salt here referred to, and which contains two atoms of potassium to one molecule of acid; the binoxalate, the ordinary salt of sorrel of the drug stores, and that which is found in many plants, containing one atom of potassium to one of acid; and the quadroxalate, a salt not frequently prepared or used, in which the proportions of potassium and acid are one to two. The neutral salt is the only one used in photography. It crystallizes in rhombic prisms, is stable in the air, contains 2 molecules of water of crystallization which may be driven off by heat, and is soluble in about 3 times its weight of cold water.

It is evident that the easiest mode of preparing this salt is by neutralizing a solution of carbonate of potassium by oxalic acid. Some have recommended that the ordinary salt of sorrel (*sal acetosella*) be rendered neutral by the addition of the carbonate, but this is certainly a roundabout and expensive plan, not only as involving the use of more costly material, but unnecessary evaporation. The most expeditious method will be found to be as follows:—Dissolve a quantity—say 1 lb.—of carbonate of potassium in an equal weight of cold water, decanting the clear solution from any undissolved sediment, if such should remain. This residue consists of potassium sulphate or silicate, and is commonly present in the ordinary salts of tartar of commerce. Put the clear solution in an enamelled iron, porcelain, or wedgwood dish, add a quantity of water equal to that first employed, and heat to the boiling-point.

Add carefully, and by small portions, avoiding mishap by effervescence, sufficient powdered oxalic acid to neutralize the carbonate, testing carefully towards the close with test-paper. If necessary, filter the solution while hot, and set aside to crystallize. A fresh crop of crystals may of course be obtained by evaporating the mother-liquor.

The quantity of oxalic acid required cannot be definitely stated, as both acid and carbonate are generally impure; but theoretically, 174 parts of carbonate should require 90 of acid, and produce 202 of neutral oxalate. The product will practically be always considerably less than this, seldom equalling more than the weight of the carbonate employed.

As has been stated, the neutral oxalate is soluble in about 3 times its weight of water, and as photographers use a saturated solution, there is no reason, if time be an object, why a liquor should not be prepared extemporaneously, or at least that the operation of crystallization might not be omitted. The specific gravity of such a solution is, at ordinary temperatures, 1·220, and 10 oz. of the salt, when dissolved, measure 26 fl. oz. Such a solution, except made with distilled water, will of course require filtering, as the lime present in ordinary water is precipitated as oxalate. (E. B. Shuttleworth.)

PRESERVING.—The art of preserving is a most comprehensive subject, and includes the methods adapted to delay the decomposition, oxidation, or destruction by any other means of all those substances which are useful to man. For facility of reference, as well as systematic treatment, the subject is divided into the following sections:

Charred Paper. — Collodion is poured over the charred paper. In a few minutes this dries, and a tough transparent coating is produced, through which the printing, &c., can be seen. Bank-notes and other documents charred by fire have been thus successfully treated. (*Scient. Amer.*)

Food.—The object here will be to avoid such matters as may be found in a handbook of cookery, and to confine attention to the processes which have been devised for wholesale purposes. The subject may be divided into the following heads:—

Beer.—(1) Acid sulphite of lime is recommended to be added to beer which has to be kept for a length of time in warm places, or to undergo transmarine exportation; 1 gal. of the aqueous solution (commercial) is added to 1000 gal. beer. (2) Lockwood makes a condensed beer thus:—Beer or stout is taken when fit for drinking, and evaporated in a vacuum pan until much of the water and alcohol is distilled away, and the liquor is reduced to a thick viscous fluid. The alcohol and water pass off in vapour, which is condensed in a receiver attached to the vacuum pan, and the alcohol is obtained by redistilling. This alcohol may be re-mixed with the condensed beer. The beer is reduced to $\frac{1}{8}$ or $\frac{1}{12}$ of its bulk, according to its strength, and as fermentation is suspended by the heat employed, the condensed mixture keeps good for any length of time in any climate. The process of re-making the beer is also simple, consisting in merely adding the bulk of water originally abstracted, and setting up fermentation by the use of a little yeast. Within 48 hours the beer may be drawn from the tap for use, or bottled; or may be bottled and charged with carbonic acid gas by an aërating machine.

Fish. — Before alluding to recent processes for preserving fish in a fresh state, some space may be devoted to the ordinary methods of curing fish.

Herrings.—The fish are spread on a floor, and sprinkled with salt; when sufficiently salted, they are thrown into large vats, and washed. Each fish is then threaded through the gills, on long thin spits holding 25 each. These are hung upon trestles in the smoking-room, where fires of oak-boughs are kept smouldering. For "bloaters," to be consumed in England, the smoking lasts about 24 hours; "red-herrings" for export are salted more, and are smoked for 3 or 4 to 40 days, usually about 14 days. "Kippers" are taken while fresh, and split up. They are then washed, and thrown into vats with plenty of salt for a few minutes; finally they are spread out on tenter-hooks, on racks, and hung up for 8 hours' smoking.

Oysters.—A method of preserving oysters is adopted by the Chinese. The fish are taken from the shells, plunged into boiling water for an instant, and then exposed to the sun till all the moisture is removed. They remain fresh for a long time, and retain their full flavour. Only the fattest can be so treated. Oysters are also largely "canned," much in the same way as salmon.

Salmon.—The fish are beheaded and cleaned, and cut by a series of knives into the right lengths to fill 1-lb. cans. When these have been filled to within ¼ in. of the top, the covers are put on and soldered. In an air-tight condition, the full cans are passed to the boilers, vats measuring 5 ft. × 4 ft. × 4 ft., where they are steamed for 1 hour. They are then taken out and cooled. A small hole in the centre of each lid, hitherto remaining soldered up, is opened by applying a hot iron, and the air and cooking-gases are allowed to escape. The cans are then instantaneously made air-tight again, and are boiled for two hours in a bath of salted water, the salt being added to raise the boiling-point. They are then left to stand till quite cool.

Sardines.—The beheaded and cleaned fish are spread upon sieves, and plunged for 1 or 2 minutes beneath the surface of boiling oil in coppers. After draining a little, the fish are packed closely in tin boxes, which are filled up with pure cold oil, and soldered. The quality deteriorates with every immersion, owing to the matters disengaged by the boiling oil, and the coppers need frequent replenishing with oil.

Shrimps.—To preserve shrimps in a dried state, they are boiled for ½ hour with frequent sprinkling of salt; then spread out on hard dry ground, with frequent turning, to dry and bleach for 3 or 4 days. They are then trampled to remove the shells, and are winnowed and bagged.

Eckart's process.—This consists in the application of an antiseptic under great pressure. The antiseptic solution is made by adding 33 lb. salt and ¼ lb. saltpetre to 100 lb. water; and ⅓ lb. salicylic acid to 100 lb. of water. A mixture is then made of 75 parts of the salt solution and 25 of the salicylic acid solution. This is applied under a pressure of at least 12 atmos. The goods are then packed in barrels or cases, and surrounded with gelatine, to exclude the air and prevent desiccation. The fish keep good and retain their flavour for 10 or 14 days. The same process is applicable to meat, game, &c.

Refrigeration.—This process, described further on under Meat, is equally applicable to all kinds of fish.

Fruit, Grain, and Vegetables.—For the preservation of grain no further precautions are necessary beyond gathering it when ripe, and keeping it dry.

Desiccation.—The simplest form of desiccation is by ordinary sun- and wind-drying, as conducted in hay-making. The next step is by radiated sun-heat, as in coffee-drying; a further advance is made by the application of artificial heat, as in hop-drying and tea-drying. The primary object in all these cases is the removal of the water mechanically present, and without whose presence fungoid growths and decay cannot exist. As a curative agent simply, the application of heat is, however, unnecessary and injurious, causing a partial destruction of the flavour, and more or less fermentative change. Research has proved that between the limits of 32° and 60° F. (0° and 15° C.) vegetable substances retain their flavour and all other qualities, while giving up their moisture, no fermentative action being engendered. This has led to the adoption of the

Cold-blast system.—The fruit or vegetables are deprived of moisture by subjection to dried air at a low temperature. The air is compressed in a chamber containing chloride of calcium, or any other compound possessing strong dehydrating qualities. Chloride of calcium is in practice probably the best, as it so readily gives up the absorbed water on being heated. The compressed and dried air is then admitted into a chamber containing the substances to be treated. The expansion lowers its temperature somewhat, which should be maintained between 32° and 60° F. (0° and 15° C.). The substances are distributed throughout this chamber on perforated trays, so as to be fully exposed to the current of cold dry air passing through. All the moisture is thus removed, without the least detriment to the flavour, colour, and other virtues of the substance acted upon. The process has a great advantage over hot-drying, both in the cost entailed and the result achieved. Fruit and vegetables thus prepared, and packed with ordinary care, remain good for an indefinite period, and resume their natural shape and dimensions when placed in water.

Hot-air process.—(1) Great quantities of vegetables continue to be prepared by this process, which has been in use for some time by Whitehead and other well-known firms. A common method of conducting the operation is as follows:—The fruit or vegetable is pared and cored, if necessary, and then finely shredded. The shreds are spread on galvanized-iron wire screens in the evaporator, a 3-storeyed chamber, through which passes a current of air heated to 240° F. (116° C.). The screens rest on endless chains, that move upwards at intervals of 3 to 5 minutes, when a fresh screen is put on below, and a finished one is taken off at the top. The evaporation is very rapid. The cores and peelings of apples, &c., are made into vinegar. (2) Another plan is by means of a vacuum-pan, heated to 120° to 170° F. (49° to 77° C.). The air is dried by passage over chloride of calcium. The operation occupies 20 minutes.

Masson and Gannal's process.—Vegetables are submitted for a few minutes to steam at 70 lb. a sq. in., then dried by air at 212° F. (100° C.), subjected to hydraulic pressure so as to form tablets, and, when required for use, are soaked in cold water for 5 hours.

Carsten's process for Potatoes.—The potatoes are peeled and cut into discs, and are scalded by immersion in nearly boiling water. They are then dried hard in an oven. To preserve the white colour, they are treated with water acidulated with 1 per cent. of sulphuric acid. They are then washed in cold water, and dried.

Quick-lime for Potatoes.—For preserving potatoes in store, the floor is sprinkled with fine quick-lime; this is covered with a layer (4 to 5 in. thick) of potatoes; this by a sprinkling of quick-lime again, and so on, using the lime in the proportion of about 1 measure to 40 measures of potatoes. This method checks disease when it is present, and improves the potatoes if they are watery or waxy. Layers of straw and powdered plaster of Paris may be substituted for the lime.

Sace's process.—Sace's process for preserving vegetables is as follows:—The vegetables are warmed to destroy their rigidity, and are then packed in barrels, and surrounded with ¼ their weight of acetate of soda in powder, by which their moisture is absorbed. In summer the action is immediate; but in winter it may be necessary to put the barrels into a room heated to 68° F. (20° C.). After 24 hours, the vegetables are removed, and kept in a dry atmosphere. For use, they are soaked in cold water for 12 hours.

Cooking.—The preservation of vegetables by cooking them in sealed cases is dependent upon the destruction of all organic germs by the heat of the boiling and the perfect exclusion of air. An example of the simplest form is the canning of tomatoes. The fruits are scalded to loosen the skin, and then dipped in sieves into water, heated by injection of steam, for ½ minute. They are then skinned, and picked over, and passed into the steamer. Thence they fall into the hopper, and are fed by the "stuffer," a cylinder worked by a treadle, into the cans. The filling of these is adjusted by boys, and they are sealed up. The cans are then boiled for 2 hours, then partially cooled, the air is let out by a pin-hole, and they are immediately soldered up, and the cooling is completed.

Many other vegetables are canned in a similar manner. Those which have a green colour lose it during the operation, by the destruction of the chlorophyl. The same remark applies to those dried by heat. The green colour may be replaced by adding a solution of chlorophyl, exhausted from other plants; or the natural colour may be retained by treatment with alkaline earths, according to Possoz, Biardot, and Lécuyer.

Pickling.—In pickling vegetable substances, advantage is taken of the curative properties of acids, alcohol, sugar, saltpetre, salt, &c.

By Acids.—Curing by means of acids, as acetic acid, vinegar, &c., is the process commonly known as "pickling." In the ordinary way, the vegetables are kept soaking for a long time in brine, and are then pickled by acetic acid. An improved method, by which months of time are saved, is to exhaust them under an air-pump, and then to force in spiced vinegar under a pressure of 45 lb. per sq. in.

By Alcohol.—This is too expensive for commercial purposes. An example is the preservation of cherries in brandy.

By Sugar.—Sugar is very largely used for preserving fruit in an edible condition, either in bulk or in separate pieces.

Marmalade. — The manufacture of marmalade is a type of the process carried on in bulk. The peel is removed from the oranges, and their pulp is squeezed, to liberate the juice. The peel is softened by steaming, and is then sliced by revolving knives. The pulp is boiled, and then passed through a "searcher," to remove the tough skin and pips. The juice and sliced peel are then mixed and boiled with lump-sugar in steam-jacketed copper pans. Wherever possible, the appliances used are of oak.

Candied Fruit.—The "candied-peel" of citrons, lemons, and oranges is thus prepared:—The fruits are placed in vats, and boiled till soft enough to absorb the sugar. The pulp is then entirely removed and wasted, no attempt having been made to utilize it for the production of essences or vinegar. The peel is put into tubs, and treated with hot syrup of sugar for 10 to 14 days. It is then dried on sieves, in a room heated to 100° F. (38° C.). It is finally candied by immersion in a boiling limpid syrup of sugar, left to drain on a sieve over the pan, and again hot-dried and packed. Whole fruits are prepared in a similar manner.

Honey.—Honey, according to Vogel, contains on an average 1 per cent. of formic acid. Observing that crude honey keeps better than that which has been clarified, Mylius has tried the addition of formic acid, and found that it prevents fermentation without impairing the flavour of the honey.

Meat. — Dr. Richardson says that putrefactive changes in meat are due to the decomposition of the water contained in the tissues. The means which have been found to arrest this decomposition are—(1) a low temperature (2) a high state of desiccation; (3) the application of antiseptics; (4) the exclusion of air.

Refrigeration.—Subjection to a low temperature is a thoroughly effective way of preserving meat, but it can be considered only as temporary, decomposition ensuing when the cold state is abandoned. Nevertheless, its effects are sufficiently lasting to serve practical ends, and the process seems most likely to solve the problem of conveying large quantities of fresh meat to this country. Numerous plans have been devised, all aiming at the production of a sufficiently low temperature at a remunerative cost. The principal are:—

(1) Harrison's.—The meat is first frozen, and is then packed in a chamber on board ship, the air of which is maintained in a thoroughly dry state, so as to keep up a slow but constant evaporation from the surface of the meat. The meat is placed in tanks, which are kept cool by directing a stream of brine among ice, and regulating the strength of the brine so as to produce the de-

sired degree of cold. The ice and brine are kept in tanks above the meat, and from them streams constantly trickle over and around the meat-tanks. The consumption of ice is less than 50 tons for 50 tons of meat, and the proportion decreases with larger quantities. The meat retains its full flavour, and will keep good in a temperature of 63° to 68° F. (17° to 20° C.) for 70 to 80 hours after removal from the tanks. The drawback is the bulk of ice required.

(2) Tellier's.—The joints of meat are placed in a chamber, through which is passed a current of air charged with ether or other volatile substance, so as to reduce the temperature sufficiently low to preserve the meat, without freezing its juices.

(3) Mort and Nicolle's.—In this process, the freezing agent is ammonia solution under a pressure of 50 to 70 lb. a sq. in. The freezing-room is kept below 32° F. (0° C.), and the meat is frozen quite hard.

(4) Poggiale's.—A low temperature is maintained by the evaporation of methylic ether, and circulation of chloride of calcium.

(5) Bell and Coleman's.—This process is perhaps the most completely successful of all that have been introduced, and is equally applicable to the preservation of fresh meat during transport by land or sea, and while being stored. The meat is placed in a chamber made as nearly air-tight as possible, and of the best-known non-conducting materials. The air which is made to circulate in the meat-chamber is cooled so as to maintain a temperature never exceeding 50° F. (10° C.), and never so low as to actually freeze the meat. The cold is obtained by the re-expansion of compressed and cooled air. Cold-producing machines on this principle are by no means new, but a great difficulty hitherto met with in applying this system has been the formation of particles of ice during the re-expansion. This is avoided by a more effectual cooling of the compressed air, and by subsequently treating the air so as to separate moisture from it, by subjecting it, before re-expansion, to an atmosphere cool enough to ensure the deposition of any remaining moisture that would be liable to freeze; moreover, care is taken that the air shall not be so highly dried as to have a desiccating effect upon the meat.

(6) Knott's and Kent's.—In Knott's refrigerating-car, air is cooled by passage over a freezing-mixture, or ice alone, and a constant circulation of it is kept up, the temperature being best maintained at a little above the freezing-point, say at 33° F. The air is both dried and cooled. Kent's well-known refrigerator-safes are made upon much the same principle, the great feature being a downward draught. Importations of meat from America have been made by this system, the meat being sewn up in bags and suspended in a chamber surrounded by a temperature of about 37° F. (3° C.), the draught being produced by a steam-fan worked over the ice-tanks.

Desiccation.—Animal matter, preserved by the absorption of its moisture, loses its flavour, and becomes tough and indigestible; the fat becomes rancid, and in damp weather the meat absorbs moisture, and turns mouldy and sour. These tendencies are corrected by adding absorbent substances with fat food—as sugar and spice, to form "pemmican," and farina, to produce "meat-biscuits." Altogether, the process seems ill-adapted for preserving meat in a fresh state, and two methods only need be mentioned.

(1) Tellier's.—The meat is placed in vessels whose air is repeatedly exhausted, and replaced by carbonic acid gas, which latter is finally absorbed by a concentrated solution of potash. The meat loses 18 to 20 per cent. by weight, and is kept *in vacuo*.

(2) Sacc's.—This process has been described under Fruit. When applied to meat, the brine produced furnishes an extract of meat on evaporation, the acetate of soda crystallizing out. This extract is added in the proportion of about 3 per cent. to the preserved meat. The latter, before use, requires to be steeped for 12 to 24 hours in water containing about ½ oz. sal-ammoniac to the pint.

Antiseptics.—The use of chemical antiseptics has long been known, common salt being a very generally employed agent of this class. The difficulty seems to be to ensure the meat retaining its freshness, and to avoid its acquiring any unpleasant flavour. From among the very various processes devised, the following are selected as being most noteworthy.

(1) Herzen's.—The quarter-carcases are soaked for 24 to 36 hours in a solution composed of 3 parts borax, 2 parts boracic acid, 3 saltpetre, and 1 salt, in 100 parts water; they are then packed with some of the same. Before use, they need 24 hours' soaking in fresh water.

(2) Reynoso's.—The meat is subjected to the action of compressed nitrogen, carbonic oxide, &c. After being kept in this state for 40 days, the freshness has been so maintained that blood has flowed from the joints.

(3) Richardson's.—Dr. Richardson made some test experiments with meat treated with various antiseptics, under a temperature varying from 45° F. (7° C.) to 110° F. (43° C.), for a period of 75 days. The results may be summarized thus:—Methylene: preservation, good; colour, imperfect. Methylal: faint taint of decomposition. Cyanogen: preservation, excellent; colour, perfect; structure, firm. Sulphurous acid: some tainted; colour, dark. Sulphurous acid and lime-juice: some tainted; colour, indifferent. Sulphurous acid and glucose: some tainted; structure, dense. Nitrate of methyl: preservation, good; colour, yellowish; structure, firm. Formates: entirely fresh, and excellent in colour.

(4) Estor's.—This consists in treatment with sulphurous acid and chlorine in succession.

(5) Gamgee's.—The animals are killed by inhaling carbonic acid, &c., and the carcases are kept in an atmosphere of carbonic or sulphurous acid. This does not prevent decomposition where bruises exist.

(6) Medlock and Bailey's.—The meat is immersed in a solution composed of equal parts of water and bisulphite of lime, of 1·05 sp. gr. It acquires no unpleasant flavour. This is one of the most successful of the antiseptic processes.

(7) Pelletier's.—The meat is covered with a coating of gum, then immersed in acetate of alumina, then in solution of gelatine, allowing the whole to dry on the surface. The antiseptic acetate of alumina forms an insoluble compound with the gelatine.

(8) Pagliare's.—Gum benzoin is boiled in a solution of alum. The meat is immersed in this compound, and excess moisture is driven off by a current of hot air, leaving the antiseptic on the meat.

(9) Jones and Trevethick's.—The meat is put into tin canisters, which are hermetically closed, except two holes in the lid. These are plunged into a vessel containing water, and after the air has been exhausted by an air-pump through one hole, sulphurous acid gas is admitted through the second, and this alternation is continued till all the air is out. The sulphurous gas is then replaced by nitrogen, and the holes are closed.

Exclusion of Air.—As the presence of oxygen seems to be essential to the existence of decomposition, many plans for the preservation of meat have been based upon the exclusion of air from it. By far the most important are the numerous modifications of cooking in air-tight cans, called "canning," which have been conducted for years with great success. The heat of the cooking destroys any microscopic germs, if such be present, and at the same time expels all air from the receptacle and from the substance itself. The preservation is complete, but over-cooking is unavoidable, and the meat is rendered soft, fibrous, and insipid.

(1) "Canning."—There are three chief modifications of the canning process—(*a*) "Aberdeen;" (*b*) "steam-retort;" (*c*) "chloride calcium bath." The Aberdeen process probably originated with Appert, whose plan was brought into use during the Crimean war. The meat is placed in vessels nearly closed;

these are then put into a close boiler, and the heat is raised to 234° F. (112° C.). After about 3 hours' cooking, the vessels are hermetically sealed. McCall's improvement upon this consists in the addition of a little sulphite of soda. Jones' improvement lies in the fact that the water is first driven off at 230° F. (110° C.) *in vacuo*, and the heat is then raised to, and kept at, 270° F. (132° C.). The special feature is the vacuum, all the oxygen being extracted by means of tubes connecting the tins with the vacuum-chamber; this greatly reduces the time. By the steam-retort plan, the meat is canned up, leaving a pin-hole, and the cans are put into a retort under steam at 230° F. (110° C.), and kept there for 1½ to 2 hours; they are then taken out, and the pin-holes are soldered up while steam is issuing from them. The cans are again steamed at 240° F. (116° C.), and cooled. The object of the chloride of calcium bath is to obtain a higher temperature. The raw meat is put into cans having a pin-hole, as before. The cans are placed for half their depth in a solution of chloride of calcium, boiling at 260° to 270° F. (127° to 132° C.). The heat is gradually raised from 180° F. (82° C.) to 230° F. (110° C.), and the steam is allowed to blow off for 4 hours, during which time the meat is being cooked. The holes are then closed by a drop of solder, the heat is raised to 260° to 270° F. (127° to 132° C.) for ½ hour, and the cans are withdrawn and cooled. Ritchie's deviation from this consists chiefly in desiccating the meat first in an oven at 400° to 420° F. (204° to 216° C.), and then packing it in cans, with the addition of meat jelly to create steam, before subjection to the chloride of calcium bath.

(2) Naylor's process.—The meat is cooked, and then packed in cases, and covered with stearine (tallow).

(3) Redwood's process.—The meat is immersed in melted paraffin at 240° F. (115° C.), to concentrate the juices, and expel the air. Thus condensed, the meat is covered with a coating of paraffin. Before use, it is placed in boiling water, which removes the paraffin; it can only be used in its cold state, not bearing re-cooking.

Milk.—(1) Condensed Milk.—The compound known as "condensed milk" is an illustration of the application of the drying or desiccation theory, accomplished by evaporating the excess of moisture, adding sugar, and packing in hermetically-sealed vessels. The milk, as received from the dairies, is placed in vessels having a capacity of 750 to 1000 gal., where it is maintained at a slightly raised temperature by means of steam-heat, and undergoes evaporation *in vacuo*. The duration of the process varies from 2 to 5½ hours. Refined sugar in powder is added in the proportion of about ⅓ by weight of the total condensed product; and when the mass assumes the consistency of thick honey, it is put into tin boxes, and hermetically sealed. The proper conduct of the operation is by no means easy. There is much danger of a decomposition of the caseine in the presence of heat and sugar, especially if the milk has been in the slightest degree "turned"; also much of the fatty constituents will distil with the water, if the temperature is allowed to exceed 100° F. (38° C.). Attention has recently been called, in the *Analyst* and elsewhere, to the fact that these unfavourable conditions do frequently come into play, and that the loss of nitrogenous matter by decomposition, and the loss of equally important fat, partly volatilized, partly decomposed, so generally sustained by condensed milk, render it unfit to replace new milk in the nursery. Small quantities are prepared (almost solely for the American market) without the addition of sugar, in which case the evil is lessened; but the product does not keep so well.

(2) Mabrun's process.—This simple process was probably the foundation of the preceding. The milk is warmed at a moderate temperature, in a tin vessel furnished with a leaden tube for the expulsion of the air. The tube is then compressed, and the orifice is soldered up. After 6 months' keeping, the milk

is as good as new. The process received a prize of 1500 fr. from the French Academy of Sciences.

(3) Morfit's process.—In 1 gal. milk at 130° to 140° F. (55° to 60° C.) is dissolved 1 lb. gelatine; the mixture is left to cool to a jelly, when it is cut into slices and dried. The compound is used to gelatinize more milk, and this is repeated till the gelatine is in the proportion of 1 lb. to 10 gal. of milk.

(4) Neumann points out that the electric state of milk, as affected by the bodies with which it comes in contact, exerts an unquestionable influence over its keeping. Milk which has stood in a tin vessel, and is turned out into glass or pewter, will not keep sweet so long as if left in the tin. Milk will keep well in zinc, antimony, bismuth, copper, brass, or iron vessels; but iron is apt to impart a disagreeable taste; and copper, after a while, is found in notable proportion in the milk. Caution is therefore requisite with utensils of this metal. Block-tin vessels are best; but the milk should not be shifted from vessel to vessel, and the latter should be filled as full as possible.

(5) When milk contained in wire-corked bottles is heated to the boiling-point in a water-bath, the oxygen of the included small portion of air under the cork seems to be carbonated, and the milk will, it is said, keep fresh for a year or two.

(6) Glacialine.—According to Dr. Besana, this substance, which has met with so much favour in England and elsewhere as an antiseptic, especially for the preservation of ·milk, has the following composition:—Boracic acid, 18 parts; borax, 9; sugar, 9; glycerine, 6.

(7) A mixture of 2 dr. boracic acid with 3 dr. common salt, of which an addition of ⅔ dr. to 1 gal. of milk is said to increase its keeping qualities for 24 hours.

(8) According to Prof. Caldwell, boracic acid is the best antiseptic for preserving milk or keeping it sound for an unusual length of time. When the temperature was 80° F. (27° C.), and the milk soured in 20 to 22 hours, 1 part boracic acid, added to 500 of milk, caused it to remain sweet for 50 hours. Again, he found that 1 part boracic acid, added to 1000 of milk by weight, kept it sweet for a space of 50 hours when the temperature was 72° F. (22° C.). When applied to milk warm from the cow, it kept it sweet and sound twice as long as milk not treated with it. No injury occurs to the milk in using 1 part boracic acid for 1000 of milk. Boracic acid, he stated, was not poisonous. He had partaken of milk thus preserved, and no harm resulted from the taking of such milk into the stomach.

(9) Portch states that salicylic acid cannot be considered a success for preserving milk or butter, as it conveys an unpleasant sweetish flavour, which increases till decomposition ensues.

Fruit-juices.—Formic acid is said to possess powerful preservative properties, exceeding, when added to acid solutions, even carbolic acid, and to be particularly suitable for adding to fruit juices; about ¼ to ½ per cent. is the quantity requisite to preserve fruit juices, vinegar, glue, ink, &c.

Gum.—Hirschberg adds a few drops of sulphuric acid, whereby the lime contained in the gum is precipitated as sulphate; after standing, the mucilage is strained off, and exhibits no tendency to mouldiness even after standing for 18 months. (*Les Mondes.*)

Hay.—Professor Wrightson, of the Royal Agricultural College, Cirencester, writes to the 'Times' as follows:—Will you allow me a few lines' space to call attention at this seasonable time of the year to a process of preserving fodder for winter use little known, and, so far as I am aware, never practised in this country? It gives as its product what is known all over the Austrian Empire as "sour" hay, which, I may add, I have seen used extensively on many large estates. The process of making sour hay is not only exceedingly simple, but in the event of a wet season might be adopted in this humid climate with excellent effects, as neither drying wind nor sun are required. The green grass, green Indian corn, or other fodder is simply crammed down into graves or trenches, 4 ft. wide and 6 ft. to 8 ft. deep, until it forms a compact mass up to the surface, and the whole is then covered with 1 ft., or rather more, of earth, rounded over so as to form a long mound. No salt is used, and the wetter the fodder goes the better. The preservation is complete, and when cut out with a hay spade in winter, the fodder is of a rich brown colour, and exhales a slightly sour, but on the whole agreeable flavour."

Indiarubber.—(1) In the opinion of Hempel, the hardening of vulcanized indiarubber is caused by the gradual evaporation of the solvent liquids contained in the indiarubber, and introduced during the process of vulcanization. Guided by this notion, he has made experiments for a number of years in order to find a method for preserving the indiarubber. He now finds that keeping in an atmosphere saturated with the vapours of the solvents answers the purpose. Indiarubber stoppers, tubing, &c., which still possess their elasticity, are to be kept in vessels containing a dish filled with common petroleum. Keeping in wooden boxes is objectionable, while keeping in airtight glass vessels alone is sufficient to preserve indiarubber for a long time. Exposure to light should be avoided as much as possible. Old hard indiarubber may be softened again by letting the vapour of carbon bisulphide act upon it. As soon as it has become soft, it must be removed from the carbon bisulphide atmosphere and kept in the above way. Hard stoppers are easily made fit for use again in this manner, but the elastic properties of tubing cannot well be restored. (*Ber. Chem. Ges.*) (2) In order to prevent indiarubber materials from hardening and cracking, they are steeped in a bath of melted paraffin for a few seconds, or several minutes, in accordance with the size of the articles, and then dried in a room heated to about 212° F. (100° C.).

Leather.—(1) Equal parts of mutton fat and linseed-oil, mixed with ⅒ their weight of Venice turpentine, and melted together in an earthen pipkin, will produce a "dubbin" which is very efficacious in preserving leather when exposed to wet or snow, &c. It should be applied when the leather is quite dry and warm. (2) Many other formulæ exist for dubbins, but all contain essentially the same ingredients. (3) A solution of 1 oz. solid paraffin in 1 pint light naphtha, to which 6 drops sweet-oil have been added, is put cold on the soles, until they will absorb no more. One dressing will do for the uppers. This process vastly increases the tensile strength of every stitch; and, while not removing the natural moisture of the leather, decidedly waterproofs the boot. A sole lasts 2 months longer when so treated. (4) There is nothing like castor-oil for preserving leather. Applied once a month, or once or twice a week in snowy weather, it not only keeps the leather soft, but makes it waterproof. Copal varnish is the best thing to apply to the soles; but the latter should be thoroughly dry, and if they have been worn, they should be previously roughed on the surface before applying the varnish. Linseed-oil is perhaps better than nothing, but it rots the leather; hence the objection to "dubbins" and other mix-ups of mutton-suet, linseed-oil, &c. The very best thing for waterproofing soles is Szerelmey's freestone liquid; 3 or 4 coats of this render the sole perfectly waterproof, and more durable. With regard to castor-oil, it may further be said that it does not prevent a polish being produced on the boots, and that leather so treated is avoided by rats, if even its proportion be only ¼ to ⅔ tallow. (5) Long-continued observation shows that harness and other leather exposed to the action of ammonia continually given off in stables, become weak and rotten sooner than ordinary leather. Even when care is taken to protect them with grease, this takes place. The addition of a small quantity of glycerine to the oil or fat employed in greasing such kind of leather has been recommended to keep it always pliable and soft.

Leeches.—The health and "biting"

propensities of the *Sanguisuga* depend upon a number of circumstances, some of which are rather obscure, but it may be stated in general terms that the absence of decaying animal matter, and of too great an excess of lime-salts, are points which should be aimed at most particularly. Sudden changes of temperature are also detrimental to leeches, which should, as may be inferred from the preceding remarks, be kept in soft water of good quality frequently renewed, provided it is not too pure to afford them nutriment. They are peculiarly sensitive to electrical influences; many confined in the usual small receptacles will sicken and die, apparently "quite unaccountably," but really from the effects of that electro-inductive condition existing before a thunderstorm, and popularly known as "thunder in the air." If the usual leech-vase or barrel, say of glass or china, be put into direct conductive communication with the earth by means of a stout metallic chain dipping into the water and connected by its other extremity to, say, the gas- or water-pipes of a house, fewer leeches in summer will die than if this precaution is not taken. When kept in the usual rather small vessels, the water should be, if possible, rain-water of good quality, renewed every 8 or 10 days with fresh water of the same temperature * as that in the leech-vase itself. Dust must be excluded from the vessel by a covering of fine gauze, and the bottom should be occupied by a layer of clean fine gravel or coarse sand, to which has been added a few lumps of well-burnt oak or pine-wood charcoal. The whole of this bottom layer should be renewed within 6 to 8 or 10 weeks, according to the time of year. A little pure "crystallized" binoxide of manganese in the granular condition, and carefully freed from fine powder by sifting, is often of great assistance in keeping the water in a wholesome condition. Towards the same end also, a few growing plants of the *Vallineris spiralis* will powerfully contribute; but perhaps the most efficient factor in this direction, wherever it can be applied, is an arrangement for keeping the water slightly agitated and at the same time well aerated. This object can be readily attained by any simple "aspirator," whereby a slow current of water forces air down a small glass tube turning up under the surface of the fluid in the leech receptacle. In the end of this tube a small transverse section of dry cane should be cemented, so that the air emitted is distributed in minute bubbles. (*Burgoyne's Monthly.*)

(2) Complaints are frequently heard of the inability of chemists to keep their leeches in health for any length of time. I have avoided the advertised leech aquariums and the like, and have for years kept leeches in perfect health by the following simple plan:—I got a 7-lb. ointment jar, made of glazed white earthenware, and put my leeches into it. Then, instead of replacing the top, I covered the jar with white muslin, and tied it round tightly. The water was never allowed to go unchanged more than a week; and by these simple means I have been able to keep all the leeches alive for months, even during the hottest weather, when the mortality amongst them is usually very great. (E. F. Cherry.)

Lemon-juice.—(1) A correspondent in 'Mém. de Méd. et de Pharm. Milit.' says, after various experiments and the test of 8 months' exposure to the sun and heat of summer, he has come to the following conclusion:—Heating the juice, or adding alcohol to the same, would appear to be superfluous, as it is only necessary to filter it and keep it in sealed bottles; however, since filtration proceeds so very slowly, the best way is, perhaps, to add 10 per cent. of alcohol to the fresh juice, and bottle.

(2) The 'Pharm. Jl.' observes that it may be preserved, without the addition of alcohol, by heating it to 150° F. ($65\frac{1}{2}$° C.), and then excluding it from the air by carefully closing the full bottles at this temperature. The operation should be carried out in winter.

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* As far as possible this should be kept within the limits 55° to 75° F. (13° to 24° C.)

Raulin's and Pasteur's Fluids.—Both Pasteur's and Raulin's fluids are very difficult to keep. They are so extremely sensitive that the simple exposure of the fluids to air for 2 or 3 days (in a town) is sufficient to convert the whole into a ropy mass of mycelium. Then, again, starch solution is not easy to keep for any length of time. Chemists have, it is true, succeeded somewhat by the application of salt, calcium chloride, and other antiseptics; but these more or less interfere with the universal application of starch solution, and could not be used at all with either Pasteur's or Raulin's fluid. Two years ago, G. E. Davis devised a plan for keeping such fluids as are above-mentioned, and with the result that the remainder of a pint of Raulin's fluid made up in November, 1878, was as good 4 years after as when first mixed. The apparatus consists of an ordinary glass flask, fitted with an indiarubber stopper pierced with 2 holes, into one of which is tightly inserted a tube packed with clean cotton wool. Into the other hole the shorter limb of a glass siphon is inserted, the longer limb being closed with a spring clip upon a short length of rubber-tubing, in advance of which is a narrow glass jet. To put the apparatus in working order, nearly fill the flask with the fluid, and take out the cotton wool from the tube above; place over a lamp to boil, and, while boiling, open the clip, and stop up the open end of the wool tube, so that the pressure may drive some of the fluid out of the flask. Return this ejected fluid to the flask, and keep boiling for 5 minutes, allowing the steam to escape from the open wool tube. While steam is thus escaping, place a plug about ½ in. in depth of cotton wool, and allow the steam to blow well through it. After 1 minute, plug the whole of the tube with cotton wool, and withdraw the flame. By simply opening the clip, a supply may now be withdrawn without the introduction of any atmospheric germs into the flask. (*Northern Microscopist.*)

Skins and Furs.—(1) About 40 years ago, Waterton, at the request of the Society of Arts, described his method of preparing and preserving the skins of animals and birds, which was published in the 'Transactions.' The material used was simply mercury chloride (corrosive sublimate) dissolved in alcohol to saturation. This was applied with a camel-hair brush to the inside of the skin, the roots of the principal feathers, and all parts subject to decay. It was stated to give a remarkable firmness of attachment to feathers liable to come out, and so cleanly in use that the plumage of the most brilliant humming-bird was not soiled by its application. The corrosive sublimate must be very finely pounded. Highly-rectified spirits of wine may be diluted with water equal in quantity. Thus, to 1 qt. bottle of alcohol add 1 qt. bottle of water. Into this put a tablespoonful of corrosive sublimate, and nothing more is required. Birds must be steeped in this solution before they are skinned; quadrupeds after they are skinned. Insects must be steeped after they have been dissected. So must serpents. (2) To preserve skins of any kind. First stretch them out on a board with tacks as soon as taken from the body; then cover them with wood-ashes; let them remain a fortnight, and renew the ashes every 3 days. (3) The following soap is recommended by Ward, of London:—The skins must be well scraped and divested of all fat, and well rubbed with the soap: 1 lb. yellow soap, 1 oz. lime, 1 oz. camphor, 1 oz. arsenic, 1 oz. alum; mixed together. (4) Sublimed sulphur and nitrate of potash, of each 2 dr.; black pepper, camphor, bichloride of mercury, burnt alum, and tobacco, of each ½ oz.; reduce to a fine powder. (5) *Bichloride of* mercury, 1 oz.; hydrochloric acid, 3 dr.; methylated spirit of wine, add to, 2 oz. Use it as follows:—Pour sufficient into a cup, and paint it freely on with a brush, especially about the cavities of the skull, the arms, wings, and thighs. A liberal supply of the powder (No. 4) afterwards to the same parts will ensure their keeping any length of time (that is, if you have any doubt about their keeping). If you would prefer it, you may use the powder alone. (6) To preserve and render the skins of moles soft and pliant, soak them for 3 or 4 days in water which has had oak sapling bark boiled in it for 2 or 3 hours. To 2 qt. water put a good double-handful or more of oak-bark, or, better still, oak-galls, and when this has got cold, put the mole-skins in, fresh flayed. They will dry soft and pliant, and perfectly cured. (7) Nothing is required to preserve mole-skins but drying. Skin them neatly, turn them inside out, hang to dry, turn them when dry, and scrape them with blunt knife. (8) A very cheap and efficient way to preserve mole-skins is the following:—Stretch the skin well on a board, with the fur downwards, and keep it in position by nailing it with tinned tacks round the edge. Then saturate it with spirits of camphor, and rub it in; after this pour about a teaspoonful of rum on, and rub this in with common yellow soap, and leave it to dry. In 2 or 3 days it will be ready for taking off, and will be found to keep stretched, though limp through the application of the soap. They will keep thus for any length of time in a fairly dry place. (9) Nail the fresh skin tightly and smoothly against a door, keeping the skin side out. Next proceed with a broad-bladed blunt knife to scrape away all loose pieces of flesh and fat; then rub in much chalk, and be not sparing of labour; when the chalk begins to powder and fall off, take the skin down, fill it with finely-ground alum, wrap it closely together, and keep it so in a dry place for 2 or 3 days; at the end of that time unfold it, shake out the alum, and the work is over. (10) First clean and scrape the mole-skins, then rub them over with the following mixture:—4 lb. white curd soap, 1 lb. arsenic, 1 oz. camphor. Cut the soap into thin slices, and dissolve in 1 pint water. When melted, add the arsenic and camphor, stirring them well together; reboil until a thick paste is attained, and pour it into jars while hot. When cold, tie it up carefully with bladder, and it will keep for a considerable time—2 years. (11) This process answers for any small skins of animals. Take the skin fresh, and immerse it in a strong solution of alum and salt. To ascertain when dressed enough, double the skin, flesh side outwards, twice, and press it firmly between your finger and thumb until the liquor is well pressed out. If, when opened, the crease on the skin looks white in the angle, it is dressed enough. Take it out, and immerse it just a minute in warm flour and water, and wash out the flour under a stream of water. When the skin is about half dry, lay it on a flat smooth piece of board, and scrape off the flesh with a blunt-edged knife, or rub it off with pumice. Your skin will then be as mellow as a Dent's kid glove. (12) The following is Dr. Lettsom's recipe for a mixture found to answer both for animals in cases and skins in the open air. For birds it is equally good and effective:—Corrosive sublimate, $\frac{1}{4}$ lb.; saltpetre, prepared or burnt, $\frac{1}{2}$ lb.; alum, burnt, $\frac{1}{4}$ lb.; flowers of sulphur, $\frac{1}{2}$ lb.; camphor, $\frac{1}{4}$ lb.; black pepper, 1 lb.; tobacco, ground coarse, 1 lb. Keep in glass-stoppered bottle. Give 2 or 3 good rubbings with it. (13) Swan-skin. 6 oz. arsenic, 3 oz. corrosive sublimate, 2 oz. yellow soap, 1 oz. camphor, and $\frac{1}{2}$ pint spirits of wine. Put all these ingredients in a saucepan, which place over a slow fire, stirring the mixture briskly till the several parts are dissolved and form one homogeneous mass. This may be poured into a wide-mouthed bottle, and allowed to stand till quite cold, when it will be ready for use. Of course these quantities may be increased or decreased, according to the size of the animal or bird to be operated on. If the soap and arsenic are left out, it will answer better, as they leave it greasy. To be put on with a sponge fastened on the end of a stick. Use very cautiously; mark *Poison.* (14) Small birds may be preserved for a considerable time by immersing them in brandy, or first runnings of the distillation of rum, but it may slightly discolour the plumage. After sufficient immersion, the feathers and limbs must be arranged as in life, and then slowly dried in an oven at moderate heat. (15) Make an incision from the breast-bone to the vent; with a small piece of wood work the skin from the flesh. When the leg is reached, cut through the knee-joint, and clear the shank as far as possible; then wind a bit of cotton-wool on which some arsenical soap has been put, round the bone; do the same with the other leg. Now divide spine from root of tail, taking care not to cut too near the tail feathers, or they will come out. Next skin the wings as far as possible and cut off. The skin will now be entirely clear of the body. The skin must be turned inside out, and the neck and skin gently pulled in opposite directions till the eyeballs are fully exposed. The whole of the back of the head may be cut off, and the eyes and brains taken out, and their places filled with cotton wool. The whole skin should be rubbed well with arsenical soap or plain arsenic, and the neck returned to its natural position, when, after filling the body with a little dry grass or wool, the job is done. It is very easy, and the skin of a bird is much tougher than one would suppose, though of course they vary, the night-jar being very thin, while humming-birds are fairly tough. All the apparatus required is a sharp knife and a pair of scissors, or, for large birds, a strong pair of nippers to divide the bones. Bird-skins are sent home in barrels very roughly packed.

Stone.—As regards stone, other than such specially crystalline kinds as granite, marble, porphyry, hard limestone, &c.—none of which is liable to admit access of water from its external surface—we very much doubt the efficacy of any dressing; such, for instance, as what is called silicon varnish, or anything of the kind. The real and only effective means of preventing crumbling, blowing, or exfoliation is to make sure that the blocks are cut so as to be seated in the structure on their natural beds—that is to say, horizontally parallel to the direction of their natural fissures and *laminæ*, which, in the rock, keep the direction of the dip. The reason is this: water coming into contact with the external surface of a stone, of which the natural fissures are set perpendicularly or at a high angle, will inevitably be admitted into those fissures, and it will follow them down by gravitation, and promote the entry of more water after it until the fissures are full. If such conditions be promptly followed by keen frost, for example, the water so admitted is apt to be congealed and thus expanded, and then to prise the *laminæ* asunder, and blow out or exfoliate any scale of trifling thickness; and so long as the fissures are presented externally in such directions, no dressing whatever will effectually protect the stone. When, on the other hand, the stone is laid on its natural bed, and the fissures and *laminæ* are horizontal, all wet falls harmlessly down the face of the stone (outside). It is never admitted into the substance; and, what is more, most kinds of stone which are subject to such accidents, if preserved by proper placement from the inward access of water, have a tendency to become externally case-hardened in course of time, under outward exposure to the action of air and water, by a slow process of normal crystallization, which ultimately endows them with real durability. (*Design and Work*).

Textile Fabrics.—*Bagging for Chemicals.*—A patent has been taken out by Grouchy for making bagging which resists chemical action. The bagging is plunged in the following solution at 142° F. (60° C.), and left for an hour:—

Sulphate of alumina .	2¼ lb.
Water	5½ gal.
Borate of lime . . .	2¼ lb.

The borate of lime is added after the sulphate of alumina has dissolved in the boiling water, and the whole decanted when settled. After taking out of this bath, the textiles are put in a second bath, composed of 2¼ lb. resinous soap and 2¼ lb. Marseilles soap, dissolved in 5½ gal. water and carried to the boiling-point. At the end of 10 minutes the cloths are allowed to drip, dried, and then re-washed and dried. Bagging made in this way will, it is claimed, resist the action of any acids or chemicals put into them.—(*New York Drug. Circ.*)

Linen Stuffs and Yarns.—Sails, ropes, nets, &c., keep much longer when they have been treated with tannin. Hence Lebrun recommends the following process for preserving linen goods and yarn: 2¼ lb. good oak-tan is boiled for ½ hour in 4½ gal. pure running water. After filtering and pressing the residue, you get about 3¾ gal. tanning liquor. With this the stuffs or yarns are brewed in copper, earthen, or wooden vessels, but not in iron. The fluid must completely cover the stuffs or yarns, which should be left in it for 48 hours, and stirred round in it from time to time. They are then to be taken out, wrung, washed, wrung again, and, after being dried, they show a slight leather-like colour, and withstand all the effects of damp and the action of the weather much better than those not so treated. Unbleached goods may be treated in this way as well as bleached, but they must be first steeped. Linen goods that are already partly decayed may be thus protected from further injury. Linen goods subjected to this process for 72 hours have been found unaffected by lying spread out for 10 years in a damp murky cellar, while untanned goods were almost completely destroyed.

Urine.—In the *Lyon Médicale*, Weiser recommends the use of nitrite of amyl as a disinfectant and preservative of urine, and states that it is preferable to carbolic acid, as it does not interfere with the tests for albumen.

Vaccine Lymph.—Dr. Emil Stern, of Breslau, states in the 'Breslaue ärtzliche Zeit.," that so far as he has been able to observe, a mixture of 1 per 1000 aqueous solution of thymol preserves vaccine lymph from decomposition, while it does not destroy its specific action, and the mixture is not more irritating than ordinary vaccine matter. It does not appear, however, that thymolized lymph is infallible in its action, it seeming to vary in activity according to its age.

Wood.—Those who wish to have a thorough knowledge of the causes of decay in timber, and the remedies devised for their prevention, should consult the valuable little book by Thomas Allen Britton on "Dry Rot in Timber." The subject is one which appeals to everybody having any dealing with wood for constructive purposes, and is far too commonly neglected. A brief summary of the main facts can only be given here.

The forms of decay which chiefly interest the builder are known as "wet" and "dry" rot, though both are indirectly due to the presence of moisture. In the former, it assists the decomposition of the tissues of the wood, especially those of the alburnum (sapwood); in the latter, by aiding the growth of certain cryptogams, which obtain their nutriment from the substance of the wood. The reduction of the natural moisture in the wood itself, which is effected by proper seasoning, and the prevention of the access of external moisture by a coating of some impervious substance, such as paint or tar, tend to prevent wet rot. The same means will also tend to prevent dry rot, but with the latter there is the peculiarity that an excess of moisture is unfavourable to the growth of the fungus which feeds on the wood; also, that when the circumstances are favourable, such as a moderate degree of moisture, which most woods possess in themselves, and the existence of a damp, warm, stagnant atmosphere, no mere coating of paint will prevent the mycelium of the dry-rot fungus from penetrating to the interior of the wood. This once effected, its destruction is rapid. There are several species of fungi which attack wood; the most common appear to be the *Merulius lachrymans* and the *Polyporus hybridus.* The former attacks chiefly fir and pine, and the latter oak.

The following processes have been suggested from time to time for preserving timber:—

(1) Bethell's.—This appears to be one of the most successful means yet adopted for preserving wood from dry rot, and even wet rot, or the attacks of the *white ant* and *Teredo navalis*. It consists in impregnating the substance of the wood with the oil of tar called *creosote*, from which the ammonia has been expelled, the effect being to coagulate the albumen, and thereby prevent its decomposition, also to fill the pores of the wood with a bituminous substance that excludes both air and moisture, and which is noxious to the lower forms of animal and vegetable life. In adopting this process, all moisture should be dried out of the pores of the timber. Fir or pine, while warm from the drying-house, may be immersed at once in an open tank containing hot creosote oil, when it will absorb about 8 or 9 lb. per cub. ft. For hard woods, and soft woods which are required to absorb more than 8 or 9 lb. of creosote per cub. ft., the timber should be placed in an iron cylinder with closed ends, and the creosote, which should be heated to a temperature of about 120° F. (49° C.), forced in with a pressure of 170 lb. to the sq. in. The heat must be kept up until the process is complete, to prevent the creosote from crystallizing in the pores of the wood. By this means the softer woods will easily absorb 10 to 12 lb. of the oil per cub. ft. The most effective method, however, is to exhaust the air from the cylinder after the timber is inserted, then to allow the oil to flow in, and when the cylinder is full to use a force-pump, with a pressure of 150 to 200 lb. per sq. in., until the wood has absorbed the requisite quantity of oil, as indicated by a gauge which should be fitted to the reservoir tank. The oil is usually heated by coils of pipes placed in the reservoir, through which a current of steam is passed. The quantity of creosote oil recommended to be forced into the wood is, for railway sleepers, telegraph poles, and other purposes on land, 8 to 10 lb. per cub. ft.; for piles, jetties, and other marine works, 12 lb. Into oak and other hard words it is difficult to force, even with the greatest pressure, more than 2 or 3 lb. of oil.

(2) Boucherie's.—This consists in impregnating the timber with a solution of 1 oz. copper sulphate to 100 of water, as follows:—A water-tight cap is placed on one end of the log to be saturated, and the solution is introduced within it by a flexible tube. The pressure required, not being more than 15 to 20 lb. on the sq. in., may be obtained by simply raising the tank to a height of 30 or 40 ft. from the ground. On this pressure being applied, the sap runs in a stream from the opposite end of the log. A piece of prussiate of potash rubbed on the end of the log will show if the solution has penetrated the entire length or not, for on coming in contact with the sulphate of copper it leaves a deep brown mark on the wood. Margary in his process also used sulphate of copper in the proportion of 1 lb. of the salt to 8 gal. water, in which the wood was merely steeped until thoroughly saturated, which was supposed to take 2 days for every inch in the thickness of the wood. Boucherie also used the impure pyrolignite of iron, which was found not only to preserve the wood from decay, but also to harden it.

(3) Burnettizing.—A solution of 1 lb. chloride of zinc to 4 gal. water for timber, and 1 lb. to 5 gal. for canvas, cordage, &c., in a wooden tank. These were the proportions originally specified; 1 lb. of the salt to 9 or 10 gal. water, are now more frequently used. Timber requires to be immersed for about 2 days for each inch in thickness, and afterwards taken out and left to dry for about 14 to 90 days. Canvas, ropes, &c., require to be immersed in the solution for about 48 hours, then taken out and dried. The process on wood may be more expeditiously performed by forcing the solution into the pores with a pressure of 150 lb. to the sq. in. The advantage of this process is that it renders the material to which it is applied incombustible.

(4) Kyanizing.—The timber is immersed in a saturated solution of cor-

rosive sublimate (bichloride of mercury) in a wooden tank, put together so that no metal of any kind can come in contact with the solution. 1 lb. corrosive sublimate to 10 gal. water is used when a maximum strength is required, and 1 lb. to 15 gal. when a minimum, according to the porosity of the timber; with the latter proportion, 1½ lb. will be sufficient for a load of timber of 50 cub. ft. Corrosive sublimate dissolves best in tepid water. The time required to saturate the timber depends on its thickness; 24 hours are usually allowed for each inch in thickness for boards and small timber; large timber requires 2 to 3 weeks.

(5) Payne's.—Impregnating the wood, while in a vacuum, with a strong solution of sulphate of iron, and afterwards forcing into the timber a solution of sulphate of lime or any of the alkaline carbonates, such as carbonate of soda, by which means the oxide of iron becomes insoluble. The wood is also rendered incombustible by this process.

Two conditions of construction are necessary to preserve timber from decay—(1) continual access of a free current of air, by provision of proper ventilation; (2) the assured exclusion of wet from without. Neither damp nor dry-rot will readily attack timber which is so placed and protected. What most rapidly destroys timber is the alternation of wetting and drying; the next most frequent cause of decay is the generation of fungus by reason of total atmospheric stagnation. Another point of some importance is to avoid seating timber (such as wall-plates, joists, girders, breastsummers, &c.) in or abutting immediately upon masonry or brickwork which is being laid with Portland cement. Immediately next to all such faces or butt-ends of timber, the work should be laid with mortar made of 1 part (by weight) ground quicklime and 3 parts cleanly-sifted very dry and ground coal cinders; indeed, it is best to have the lime and cinders ground together, so that they are perfectly blended: but it is indispensable to use this material at once, as it soon slakes from the action of moisture in the air. No dressing whatever will preserve timber as to which the foregoing precautions are neglected. It is, nevertheless, a good plan—in having a care on these points—to thoroughly dress internal timbers, such as girders, joists, wall-plates, rafters, window and door frames, &c., with a strong solution of carbolic acid before building them in. In sinking timber, as posts, in strong argillaceous soils, charring the heels to a height about 6 in. above-ground—and all spurs as well—is the only means of averting very prompt decay—unless it be by the costly precaution of seating the heels within pottery pipes of sufficient calibre, and filling in with smoking ground quicklime concrete mixed with crushed burnt stone.

The reports from the German and Austro-Hungarian railroads, where the ties used are mostly of oak, pine, fir, and beech, and nearly one-half of the total number in use have been subjected to antiseptic treatment according to various systems, show a reported increase in their average life over and above the average life of untreated ties, as follows:—Oak, 6 years; fir, 7; pine, 9; and beech, 9.

In an interesting paper on "House-rot" (dry and wet rot), Pudil, clerk of works to Prince Lobkovic at Bilin, states, as the result of many years' personal observation, that the rot is always more prevalent on gneiss and granitic sites, and where the soil and building materials are derived from gneiss, granite, or such like rocks, which contain a large proportion of felspar. Not only does the alkali appear to afford nutriment to the fungi, but these stones and the soils derived from them are highly hygroscopic, and occasion a certain dampness in the surroundings, which favours the development of these growths. Dr. Leube has shown that 100 parts of the said fungi, dried at a temperature of 212° F. (100° C.), gave on analysis 30·55 carbonic acid, 4·06 hydrogen, 29·92 oxygen, 2·46 nitrogen, 32·98 ash; the ash containing potash, soda, magnesia, lime, clay, iron, manganese, chlorine, sulphuric acid, carbonic acid, and silicic acid. Sound timber of the same description as that from which the fungi were taken, gave 1 per cent. of ash only. The enormously increased proportion of ash shows how largely the fungus draws upon the surrounding masonry for nutriment. (*N. D. Gewerbe Zeit.*)

The durability of wood depends on several circumstances, some being inherent to the wood itself, others owing to outward conditions. Woody fibre, by itself, is very little affected by air or water, but several other principles may be present in wood which, by entering into decomposition, induce a similar state in the woody fibre. Such are albumen, &c., which exist in the sap. Resinous bodies, by preventing the absorption of water, and by being distasteful to most insects, act as preservatives; hence, most naturally, resinous woods are durable. The heart-wood of trees is less liable to attacks from insects than the outer or splint-wood. Dry wood is also but little liable to such attacks. Young sappy wood, on the other hand, is specially prone to attacks from insects. Trees grown in cold climates and in poor soils produce wood which is, as a rule, more durable than that obtained from similar trees grown in a warmer, richer, and moister soil. Wood felled in winter is more durable than that felled in the spring or summer, probably owing to the sap not being so abundant at the former epoch. Wood placed in warm and moist situations, especially if light and air be excluded, is more liable to decay than when placed in dry, cool, and airy positions. Moisture and a close atmosphere favour the growth of peculiar fungi on the wood, which eventually favour the decomposition of the fibres and the disintegration of the mass. These fungi are generally the *Thelephora domestica*, the *Boletus destructor*, and the *Cerulius vastator*. A remedy for the ravages effected by these fungoid growths is found in the repeated application of acetate of iron made from wood vinegar. As the sap is such an active agent in the rapid decay of wood, any means by which its removal can be effected, even if only partially, will conduce much to the preservation of the wood. Soaking in cold water, boiling in water, steaming in close vessels, have all been tried, and found effective under certain circumstances. Drying and charring the external portions have also been found efficacious. To this end the wood is immersed or painted over with tar, creosote, or similar bodies, after being well kiln-dried; the tar is then lighted and allowed to char the wood superficially. When extinguished, it may again be tarred. By causing the root end of a freshly-felled tree to stand in a solution of sulphate of iron, bichloride of mercury, sulphate of copper, &c., these bodies are sucked up into the wood, and replace the sap. This method seems to be the one which gives the most promising results, and wood treated in this manner with sulphate of iron becomes extremely durable. (*Eng. Mech.*)

Inquiries into the causes of decay of timber prepared with copper salts have been made by H. Rottier, of the University of Ghent. The disappearance of the copper-sulphate may be accounted for by the presence of (1) iron, (2) certain solutions, (3) carbonic acid. The action of iron had been recognised for some time. Rottier mentions an experiment made with chips of wood impregnated with solutions of copper sulphate containing sulphate of iron in various proportions, and buried in the ground. The results showed—(1) that the ferrous sulphate had a certain antiseptic action, but much weaker than that of the copper; (2) that the duration of woods prepared with sulphate of copper solutions containing ferrous sulphate in varying proportions was nearly equal, except where the ferrous sulphate was present in very large proportion; (3) that for preserving wood, chemically pure copper sulphate offered no advantages over common commercial sulphate. The last conclusion is opposed to the view taken by Boucherie and other specialists. Rottier cites, in support of his opinions, the observations of Layen on an ancient wheel found in the copper mines of São Domingo, in Portugal. This wheel was in a perfect state of preservation, although it had been for 1400 years in water containing not only the sulphates of copper and iron, but notable quantities of the subsulphates of these metals.

Certain salts have an injurious action on wood impregnated with copper sulphate. If chips of wood so prepared are placed in a solution of chloride of lime, carbonate of soda, or carbonate of potash, the solutions will be found after a while to contain considerable quantities of copper sulphate abstracted from the wood. This shows that timber so prepared is unsuited for marine constructions. It explains, too, why such wood is liable to decay when employed in tunnels or in certain soils, as those containing much lime. The salts (as bicarbonate of lime, &c.) present in the water carry off the copper from the wood.

In certain soils carbonic acid will also abstract the copper. This may be shown by placing chips impregnated with copper sulphate in aërated water.

Rottier has endeavoured to prolong the duration of the wood by increasing the proportion of metal fixed in the ligneous fibre. Here it is necessary to have recourse to special modes of procedure, as when the wood is simply laid in a solution of the sulphate, the proportion of the latter, which becomes fixed, is pretty nearly constant and very small. He has found also—(1) That acetate of copper enables us to double the quantity of copper fixed. (2) Heating the wood also augments the quantity of copper fixed. (3) Certain organic substances have the same effect, acting on the ligneous fibre much in the same way as do mordants in dyeing processes. The effects of indigo and catechu in this respect are very remarkable. (4) The use of cuprammonium salts permits a much larger quantity of copper to be introduced into the wood. Experiments with shavings impregnated in various ways, and buried in a cesspool, proved that the durability was greater in proportion as the amount of copper fixed was larger. Acetate of copper and indigo are too uncertain for general use. The effects of heat are not so reliable. Catechu can only be employed to a limited extent. Cuprammonium salts, on the other hand, admit of general application, and the trifling increase in prime cost would be more than compensated by the longer duration of the wood. (*Revue Indust.*)

Timber thoroughly well seasoned is in that condition in which its good qualities will be preserved, so that in one sense the seasoning and preservation of timber may be taken as the same terms. But timber may be well seasoned, and yet we may place it in such unfavourable conditions that it loses the good properties it may possess, and begins to decay. The term "seasoning" therefore may be accepted as indicating the process by which we give timber good qualities, that of "preservation," the process or means adopted by which we retain in it those properties. The oldest and most generally adopted method of seasoning timber, is steeping or immersing it in water. This is based upon the fact that by placing the timber in water, the sap is washed out of the pores and the water takes its place, which, when the timber is afterwards exposed to the atmosphere, is much more easily and quickly expelled by evaporation from the timber, than the sap in the ordinary or natural condition. To obtain the best results of this mode of seasoning in the quickest way, two things are essential; the water must be running water, and it must be as pure as possible. Natural seasoning is simply exposing the timber to the air under sheds, or otherwise piled up. (*Pract. Mag.*)

(6) To preserve Woodworks that are exposed to Damp.—(*a*) For those of an extensive nature, such as bridges, &c. The Hollanders use for the preservation of their sluices and floodgates, drawbridges and other huge beams of timber exposed to the sun and constant changes of the atmosphere, a certain mixture of

pitch and tar, upon which they strew small pieces of shell broken finely—*almost* to a powder—and mixed with sea-sand, and the scales of iron, small and sifted, which incrusts and preserves it effectually. (*b*) A paint composed of sub-sulphate of iron (the refuse of the copperas pans), ground up with any common oil and thinned with coal-tar oil, having a little pitch dissolved in it, is *flexible*, and impervious to moisture. (*c*) Linseed-oil and tar, in equal parts, well boiled together, and used while boiling, rubbed plentifully over the work while hot, after being scorched all over by wood burnt under it, strikes ½ in. or more into the wood, closes the pores, and makes it hard and durable either under or out of water. (*d*) For fences and similar works, a coating of coal-tar, sanded over; or boil together 1 gal. coal-tar and 2½ lb. white copperas, and lay it on hot. (7) To prevent rot.—(*a*) Thoroughly season the wood before fixing, and when fixed, have a proper ventilation all round it. (*b*) Charring, *after seasoning, will fortify timber* against infection; so will a coating of coal-tar. (8) To cure incipient dry rot.—(*a*) If very much infected, remove the timber, and replace with new. (*b*) A pure solution of corrosive sublimate in water, in the proportion of 1 oz. to 1 gal., used hot, is considered a very effectual wash. (*c*) A solution of sulphate of copper, ½ lb. per gal. of water, laid on hot. (*d*) A strong solution of sulphate of iron; this is not so good as sulphate of copper. (*e*) A strong solution of sulphates of iron and copper in equal parts, ½ lb. of the sulphates to 1½ gal. water. (*f*) Paraffin oil, the commonest and cheapest naphtha and oil, or *a little resinous matter dissolved and* mixed with oil, will stay the wet rot. (*g*) Remove the parts affected, and wash with dilute sulphuric acid the remaining woodwork. (*h*) Dissolve 1 lb. sulphate of copper in 1 gal. boiling water, then add 1¼ lb. sulphuric acid in 6 gal. water, and *apply hot*. (9) To prevent worms in timber.—(*a*) Anointing with an oil produced by the immersion of sulphur in aquafortis (nitric acid) distilled to dryness, and exposed to dissolve in the air. (*b*) Soaking in an infusion of quassia *renders the wood bitter*. (*c*) Creosoting timber, if the smell is not objectionable. (*d*) Anointing the timber with oil of spike, juniper, or turpentine, is efficacious in some degree. (*e*) For small articles, cover freely with copal varnish in linseed-oil. (10) To prevent *worms in marine building*.—(*a*) A mixture of lime, sulphur, and colocynth with pitch. (*b*) Saturating the pores with coal-tar, either alone or after a solution of corrosive sublimate has been soaked and dried into the wood. (*c*) Sheathing with thin copper over tarred felt is esteemed the best protection for the bottoms of ships for all marine animals; the joints should be stopped with tarred oakum. (*d*) Studding the parts under water with short broad-headed nails. (11) To destroy worms in carvings.—(*a*) Fumigate the wood with benzine. (*b*) Saturate the wood with a strong solution of corrosive sublimate; if used for carvings, the colour *should be restored by ammonia, and* then by a weak solution of hydrochloric acid; the holes may be stopped up with gum and gelatine, and a varnish of resin dissolved in spirits of wine should afterwards be applied to the surface. (*c*) Whale-oil and poisonous ointments have been found of service. The wood should be carefully brushed before being operated upon. (12) To destroy ants and insects in wood.—(*a*) Corrosive sublimate is an effectual poison to them. (*b*) Oils, especially essential oils, are good preventives. (*c*) Cajeput-oil has been proved effectual for destroying the red ant. (*d*) Payne's, Bethell's, and Burnett's processes are said to be proof against the white ant of India. (*e*) Dust the parts with pounded quicklime, and then water them with the ammoniacal liquor of gas-works, when the ammonia will be instantly disengaged by the quick-lime, and this is destructive to insect life. (*f*) For the black ant, use *powdered borax*; or smear the parts frequented by them with petroleum oil; or syringe their nests with fluoric acid or spirits of tar, to be done with a leaden syringe; or pour down the holes boiling water to destroy their nests, and then stop up the holes with cement. Ants dislike arsenic, camphor, and creosote. (Britton.)

(13) Nicholson, noting that railway sleepers lying on ground which had formerly been the bed of a salt lake, in Nebraska, retained their power to resist decay for an unusually long period, and showed an excess of alkaline salts in their ash, suggests that here is a cheap and effective preservative.

(14) Lostal, a French railway contractor, recommends the use of quicklime for preserving timber. He puts the planks in tanks and covers them with quicklime, which is gradually slaked with water. Timber, such as is used in mines, takes about a week to become thoroughly impregnated. The wood acquires a remarkable hardness and toughness, and, it is said, will never rot. Beechwood has been prepared in this way for hammers and other tools in several ironworks, and is reported to have been as hard as oak, without losing its peculiar elasticity.

(15) Wood will be effectually preserved from the action of the air if it is covered by a paint-brush with a solution of persulphate of iron, marking 2° to 2½° B. The blue tint which is developed by drying changes to brown when a coat of linseed-oil is laid on. (*Revue Indust.*)

(16) Lay timber up, when perfectly dry, in an airy place, that it may not be exposed to the sun or wind, and taking care that it does not stand upright, but let it be laid along, one piece upon another, interposing here and there some short blocks, to prevent that mouldiness which is usually contracted when planks sweat. Lay planks in a stream of running water for a fortnight, and then set them up in the sun and wind, so that the air may freely pass between them, and turn them frequently. Boards thus seasoned will floor much better than those which have been kept in a dry place for many years. Elm, felled ever so green, if kept for 4 or 5 days, obtains a good seasoning and is rendered fit for immediate use. This water seasoning is not only a remedy against the worm, but also prevents distortions and warping. Where huge massy columns are to be used, it is a good plan to bore them through from end to end, as it prevents their splitting. Timbers occasionally laid in mortar, or in any part contiguous to lime, have sometimes been capped with melted pitch as a preserver from the destructive powers of lime; but it has been found to be rather hurtful than otherwise.

(17) For the purpose of preserving timber for mines, Koug packs the timber, cut in proper lengths, in a vertical position in an iron reservoir, provided with a tight-fitting cover. The vessel is then filled to about ⅘ of its capacity with a solution of the carbolate of soda. Into this he leads live steam, which speedily brings the liquid to the boiling-point. The access of the steam is continued until, by its gradual condensation, it has filled the vessel to its full capacity. The wood is then allowed to remain in the hot liquid some hours; this is drawn off, and the wood washed off with a dry steam jet.

(18) Hock dissolves paraffin in ligroin, so-called petroleum ether, kerosene, or other convenient substances, and immerses the wood to be preserved in the solution, care being taken that the wood is as dry as possible. After impregnation, the saturated wood is heated in a large retort provided with a condensing arrangement, whereby the volatile solvent is expelled and condensed for use over again, whilst the paraffin is left in the pores of the timber. Crude paraffin (containing much liquid hydrocarbons) may be employed.

(19) At Bellagio, on the lake of Como, where olive-wood is used in large quantities for the formation of various articles of turnery, the plan adopted for seasoning the wood is to boil it for about 10 minutes, and then let it dry gradually for months before using it.

(20) The best preservative against dry rot, according to the American 'Journal of Pharmacy,' is the follow-

ing:—1 part oil of cassia, 1 wood tar, and 1 train-oil; apply 3 coats on the reverse sides and on the ends of planks, floors, &c. In all probability oil of cassia plays the chief rôle as preservative.

(21) During the excavation of a canal in Berlin the workmen struck upon 12 perfectly preserved coffins, which lay apparently in 4 graves, each containing 3 superimposed coffins. The site of the discovery corresponds with the cemetery that existed even as late as 1620 in connection with the poorhouse and pestilent hospital. The corpses must in consequence have been in the earth for at least 260 years. Notwithstanding this long period, the coffins, as well as their contained bones, are in a perfect state of preservation; articles of clothing have even been found still clinging to some of the bones. Prof. Virchow found upon investigation that the coffins were coated on both sides with a thick layer of tar, the wood itself appearing to be young oak, 1 in. in thickness. A silicious crust was likewise found on the inner side of the coffins. The wood is so hard that axes and saws were broken in the attempt to cut it.

(22) Jacques first impregnates the timber thoroughly with a simple solution of soap mixed with an acid—preferably phenic acid. This causes the formation in a few days, within the wood, of a fatty acid, which is insoluble in water, and impregnates the remotest fibres. The reaction of the acid on the soap does not take place until a portion of the water has evaporated. It is claimed that more perfect impregnation can be had in this way than with creosote, and there is no danger of the washing out of the preservative from the exposed surfaces, as when sulphate of copper is used. The Government commission on technical railroad operation in France is said to favour this process.

(23) Card impregnates the wood with a solution of zinc chloride or other antiseptic soluble mineral salt, then dries the outer layers of the wood by heated air currents, and finally saturates with hot creosote-oil. The creosote-oil is to prevent the soluble antiseptic from being washed out.

(24) Richard uses common salt, in a chemically pure crystallized form, as the most efficacious preservative of timber. In combination with alum, absolute incombustibility, it is said, can be ensured by its use. (*Revue Indust.*)

(25) The well-known methods of preserving posts and wood which are partly embedded in the earth, by charring and coating with tar, are only effective when both are applied. Should the poles only be charred without the subsequent treatment with tar, the charcoal formation on the surface would act as an absorber of the moisture, and, if anything, only hasten the decay. By applying a coating of tar without previously charring, the tar would only form a casing about the wood, nor would it penetrate to the depth which the absorbing properties of the charcoaled surface would ensure. Wood that is exposed to the action of water or let into the ground should first be charred, and then before it has entirely cooled be treated with tar till the wood is thoroughly impregnated The acetic acid and oils contained in the tar are evaporated by the heat, and only the resin is left behind, which penetrates the pores of the wood and forms an air-tight and waterproof envelope. It is important to impregnate the poles a little above the line of exposure, for here it is that the action of decay affects the wood first, and where the break always occurs when removed from the earth or strained in testing. (*Ind. Blätt.*)

(26) Muller employs for the preservation of wood the phosphate of baryta formed within the fibre. The wood is first steeped in a solution of the phosphate of soda containing 7 per cent. of the salt. When dry, the wood is again treated with a solution of chloride of barium containing 13 per cent.

(27) Leech takes 1 lb. arsenious acid and dissolves it in 4 gal. water; to this he adds 1 lb. carbonate of soda, stirring

the mixture till it is thoroughly dissolved. In a separate vessel he makes a solution of 16 lb. sulphate of copper in 16 gal. water, mixes the solutions together, and places them in a wooden or a lead-lined vat. The timber is placed in this bath, and the solution heated by means of steam to the boiling-point. A few hours' soaking is said to be sufficient, but when heat is not applied the wood must remain for at least 2 or 3 days. These solutions are applicable to wood that is already in permanent position, as telegraph-poles, fences, and gates. In these and similar cases one solution should be painted on and allowed to dry before the other is applied. When possible, they should be laid on hot.

(28) Mewburn's process, so far as oak is concerned, consists simply in boiling the wood in a solution of gallo-tannic acid, the proportions of the respective ingredients being apparently immaterial. The result is the formation of an insoluble substance in the pores of the wood. One solution only is necessary for oak, on account of the tannin naturally present in that wood, the endurance of which in moist situations is proverbial. A consideration of this fact led Hatzfeld to try the effect of impregnating timber with tannin, and afterwards with acetate of iron, a process which is both cheap and useful, and which is at present being tested by a telegraph company in France.

(29) Posts and pier-piles can be rendered nearly indestructible by boring one or more holes, larger or smaller, in the centre of the butt, the whole length if desirable; then fill with boiling coal-tar and close the aperture with a long taper wedge, well driven home, which will give pressure to force the antiseptic into the inner heart pores of the mould. Were posts thus preserved, and the exterior surface dressed with resin-varnish, they would last for centuries. Wood exposed to the air should not be dressed with coal-tar, but Stockholm tar or resinous varnish; the former will rot the fibres when exposed to sun and air. Mark the posts at 6 or 8 in. above the depth they are to be placed in the earth, and bore the hole up to the mark. Then fill in with boiling coal-tar, plug up the hole, and the base of the post will outlast the upper part. The writer has also had occasion to stand posts under floor joists, as a support, when, by making a clay puddled hole, and pouring into it a gallon of boiling coal-tar as a bed for the post to stand in, it would never decay. (*Eng. Mech.*)

(30) Wood is rendered extremely durable and weather-proof by covering it with hot linseed-oil varnish, several coats being applied, each one after the preceding one is dry; finally, oil colours are applied as required. The drying requires a longer time than the ordinary process of painting. (*Dingler's Polytech. Jl.*)

(31) The following recipe is said to be a cure for dry rot:—Melt 12 oz. rosin in an iron pot, add 3 gal. train-oil, and 3 or 4 rolls brimstone; when it is thin, add Spanish brown, or red and yellow ochre, or what colour preferred; put on the wood hot and thin with a brush; give two coats.

(32) Villain and Co., of Berlin, manufacture, under the name of mycothanaton, a product which has the property of destroying dry-rot in houses and other buildings, and preventing its appearance in new ones. It may also be employed with advantage in seasoning railway sleepers, telegraph posts, beams, &c., which it effectually preserves from decay. It is a clear liquid, containing no poisonous or disagreeably smelling substance. Its presence in the atmosphere is good for the health, as it destroys miasma and ferment. Lastly, wood impregnated with it does not easily catch fire, which has been repeatedly proved. It requires boiling in a cast-iron boiler, and in this state is to be spread over the surfaces covered with dry rot by means of a large brush. During the boiling the boiler must be kept carefully closed. Wood which is to be impregnated with it must be first cleaned. The efflorescence of masonry may be prevented by smearing the walls with this liquid. In old buildings the

efflorescence should be first scraped, and after a layer of the liquid has been put on, the walls can be restored. (*Pract. Mag.*)

(33) Melsens impregnated blocks of wood with tar by alternate heatings and coolings; they were then kept 2 years in a corner of a garden in earth saturated with the products of a urinal, and were unaltered: on breaking across, it was found that lines were noticeable where the tar had not penetrated completely; the one set of split halves were kept some years in ordinary earth, the others carefully preserved; they were then steamed at 212° F. (100° C.) for 12 hours, quickly cooled in water, frozen, and left out in the open air all winter, at the end of which time they were unaltered. They were then placed in a wet situation in a garden, then on an isolated building, and then in sandy soil under a rain-water tub. Finally, after 20 years' exposure to varied deteriorating agencies, no change whatever was produced in them. By utilizing the mechanical force of condensing steam, or of the atmosphere, wood may be wholly or partially injected with tar (or other preservative agents); when not preserved, the natural course of decay is along the direction of growth, and not across it; the direction in which the preservative body is forced into the wood is the same. When the wood is only superficially injected, it is desirable that it should be shaped into the required form before applying the preservative process. (*Moniteur Quesneville.*)

(34) The value of creosote as a wood preserver is generally recognised, but the direct injection requires great quantities of heavy oil, and a desiccation of the injected pores. The high boiling-point of creosote does not permit its employment in vapour. Blythe formed the idea of saturating a jet of steam with creosote in minute division, forming, so to speak, a gaseous emulsion. The apparatus comprises a high-pressure steam-boiler; another boiler containing creosote, in which the steam is saturated; a vat, filled with creosote, to be pumped into the boiler; sheet-iron cylinders, for the pieces which are to be injected; and a system of tubing connecting the several parts. In this way Blythe completely fills the heart of oak, pine, or red beech; he uses 4 to 6 lb. of creosote for a cross-tie, and 4 lb. of brown phenic acid per cub. yd. of saturated wood or cross-ties. The apparatus can prepare 500 ties per day. The wood comes out softened, so that it can readily be bent or shaped, but it rapidly hardens. At first it shrinks, but after a few weeks it becomes seasoned, and resists the influences of moisture. Finally, the fibres are greatly strengthened.

(35) Krug employs the following simple preparation for preserving wood used in mines by a combination of creosote and soda:—An iron basin, ⅛ in. thick, about 6½ ft. deep, and 4 ft. in diameter, is sunk in the ground rather more than half its depth. By the side, and with its rim below the bottom of the first basin, is a second, not quite half its size. A third basin, about midway between the other two in size, stands with its lower edge rather higher than the upper rim of the first basin. This first one is provided with a cover, half of which is screwed on, the other half may be opened or shut close. Above the bottom it has a sieve-bottom of wire-gauze, and at the bottom a discharge-cock. Moreover, a pipe goes to the bottom, through which steam can be directly conveyed. From beneath the upper edge a pipe passes over the edge into the second basin. In the second basin is a hand forcing-pump, for pumping the impregnating fluid into the third basin, which is furnished with a discharge-cock. The operation is as follows:—The pieces of wood to be impregnated are cut to the suitable lengths required for door-posts, lintels, piles, &c., and placed perpendicularly, as closely as possible, together in the first basin, the cover of which is then closed. It is not necessary that the cover should be air-tight. Meanwhile, the third basin has been filled with creosote soda-lye, either directly or out of the second

basin, by means of the hand-pump. The lye is then admitted into the first basin till it is about ¾ full, and then steam is conveyed directly through the pipe mentioned before to the lye. The fluid gradually begins to boil, while it is increased by the condensation water of the steam, which pours in, and at last begins to flow away through the pipe which passes over the edge of the second basin. The steam is then turned off, and the wood may be left to boil for some time in the lye. When at last the lye has been discharged, and the wood been acted upon by direct steam, the cover of the basin is opened, and the impregnated wood removed. Although wood treated in this way is penetrated with the impregnating fluid only to the depth of ½ to ¾ in., it has been found perfectly unimpaired after 5 years in districts where wood not so treated rots and becomes unfit for use after 9 or 12 months. Above ground, and in places where there is no danger of fire, it is sufficient to pour creosote-oil over the wood. In a few days the wood will be sufficiently penetrated to withstand the action of the weather. (*Stummer's Ingénieur.*)

(36) The following method of preserving garden labels is recommended in a German paper:—Thoroughly soak them in a strong solution of copperas (sulphate of iron), then, after being dried, lay them in lime-water. This causes the formation in the wood of sulphate of lime, a very insoluble salt. The rapid destruction of labels by exposure to the weather is thus, it is said, prevented. Bast, mats, twine, and other substances used in tying up or covering trees and plants, when treated in the same manner, are similarly preserved. At a recent meeting of a horticultural society in Berlin, wooden labels treated thus were exhibited, and although they had been continually exposed for 2 years, they were apparently in no way affected.

(37) Paulet compares the relative advantages of copper sulphate and creosote. As regards the former preservative, this salt is poisonous to the vegetable and animal parasites which appear at the beginning of all organic decomposition. The quantity of salts of copper should be excessive when the wood is intended to be immersed in water or buried in a moist soil, because the water dissolves this salt slowly; and since sea-water enters into combination with it still more rapidly, it should be excluded from use for wood used in the sea. There is, in wood impregnated with the salts of copper, a portion of the sulphate closely united with the ligneous tissue, and another portion in excess remaining free. The latter portion dissolves first, and, carried off by the exterior fluids, only retards the loss of the metallic salt combined with the wood; but this combination itself, although more stable, does not escape removal, being accelerated or retarded according to the rapidity and ease with which the dissolving liquid is renewed. On the contrary, the quantity of metallic salts should be diminished in wood intended for constructions in the open air, in order to prevent the mechanical effect of intra-vascular crystallizations. As regards creosote-oil, it is beyond doubt that the petroleum products, containing phenic acid, are preferable to the metallic salts for wood exposed to sea-water, because naphthalene, and especially phenic acid, exert an antiseptic action, coagulate the albumen, and thus obstruct the circulation of the sap, or blood of parasites. The volatility and the solubility of these preservative agents would render their antiseptic action temporary only, if the more fixed and thicker oils which accompany them did not enclose and retain the preceding substances, at the same time obstructing all the pores of the wood, and rendering difficult the access of dissolving liquids and destructive gases. On the other hand, grave objections have been raised, from a practical point of view, either because of the restricted production of these oils, which is not sufficient for a general use of them, or because the wood thus impregnated offers great danger from fire, this wood, once on fire, being unextinguishable; on the other hand, sulphate of copper, like all the metallic

salts, renders wood uninflammable. (*Pract. Mag.*)

(38) The American Society of Civil Engineers recently appointed a committee to report upon the preservation of timber. They issued a circular to about 1000 persons, asking for replies to questions appertaining to the results of experiments in preserving wood. The replies, of which 88 have been tabulated, relate to 33 different processes of preservation carried on in America, chiefly those of Kyan, Burnett, and creosoting. The Bethell, Thilmany, and Boucherie processes, among others, have been tried. The committee have mainly directed their efforts to ascertain the causes of failure, the divergency of experience, and the conditions required to ensure success.

Kyanizing has been carried on at Lowell, Mass., since 1848, though Burnettizing was tried for a time, when it was found less effective, and was discontinued in favour of the former. The writer says that "although Kyanizing does not completely prevent the decay of wood in exposed situations, an experience of more than 30 years has satisfied us that the benefits derived from it far exceed the cost of the process." The timber is immersed, for a period depending on its thickness, in a solution of corrosive sublimate (1 lb. in 100 lb. water). For boards 1 in. thick, 2 days' immersion is allowed, and an additional day for each additional inch in the thickness. Hobart, of the Central Vermont Railroad, alludes favourably to the value of Burnettizing (or chloride of zinc process). Alexander, of the Chicago, Rock Island, and Pacific Railway, gives the results of experience on "ties" (sleepers) treated by the Burnett and creosote processes. Pine, hemlock, tamarack, and cedar ties, were laid in 1866, and then were all treated to a solution of chloride of zinc. Of the treated hemlock ties, 75 per cent. are said to be still in the track, and to have lasted well; the pine and cedar ties have worn out in the 15 years' service, while the tamarack have endured as long as the hemlock. The untreated hemlock ties are found to decay first in the centre or heart, when the spike becomes loose and the tie crumbles, but the treated ties are sound in the centre. Of the creosoted hemlock ties a less satisfactory account is given, though the process was apparently imperfectly performed. It is thought, if well done, soft-wood ties may be made to last double the usual time. Putnam confirms the value of creosoting. On the New Orleans road, creosoted timber has been entirely used since 1876, as the yellow pine and cypress timber used in the structures decayed rapidly, especially the yellow pine. Black cypress is compact, and is said to be better than the red and white kinds. The writer says his observations have convinced him "that creosoting is valuable in proportion to the amount of oil used, and, where practicable, it is advisable to saturate the timber, or having thoroughly seasoned it and exhausted the air, a body of oil should be forced in sufficient to protect the unimpregnated timber from the fermenting and destructive particles in the air." In compact timber it is desirable to destroy the ferment germs already in the timber, and prevent the entrance of others by an impervious coating. The same good account of creosoting is furnished by Howe, of the Houston and Texas Central Railway. 150,000 cross-ties and bridge-frame timber have been treated with creosote during the last 2 years; the timber used is Texas pine, a porous and perishable wood that will not last more than 2 years on the ground, or exposed. It takes when dry more than 2 gal. to the cub. ft.

At Fort Ontario, New York, the Kyan process has been used, and Judson gives some detailed information in his paper. After 40 years, the timbers thus treated have kept their place and position. All timbers whose lower ends rest upon the ground, are rotten for 6 ft. from the foot upwards. Above this, 40 per cent. are rotten enough to impair their strength, and the remaining 60 per cent. are sound. Timbers buried in well-drained earth have about 5 per cent. rotten and about 90 per cent. sound. Of timbers entirely above ground, 80 per cent. of the tops are sound. These remarks apply to timbers 12 in. square and smaller. Larger sizes show less favourable results. The process is not considered effective when moisture is present; but when there is a free circulation of air, and moist earth *is not in contact with it*, Kyanized hemlock shows 80 per cent. of sound timber after 40 years. (*Eng. Mech.*)

Yeast.—(1) The thick portion of the yeast is filled into a champagne bottle, and on top of it is poured about ½ in. of olive-oil. The bottle is then closed by tying a bladder over its top, and in order to protect it from explosion a pin is put through the bladder. So the yeast will keep well for a long time if stored in a cold place. (2) Yeast, if mixed with about ⅛ pure glycerine, also keeps well for some time if in a cool place. (*Chem. Rev.*) (3) The raw yeast is carefully washed with cold water, afterwards the greater part of the water is removed by pressure; a further proportion is got rid of by means of a centrifugal apparatus. But as the yeast cannot be got perfectly dry in this way, it is afterwards placed for that purpose in an apparatus in which a vacuum, or rarefaction of the air nearly approaching a vacuum, can be obtained. In this chamber, the moisture, still combined with the yeast, evaporates *at a very low degree of heat*, and the vapour formed is immediately absorbed by hygroscopic substances introduced for the purpose — as, for example, chloride of lime. The yeast is finally exposed to a current of air in its ordinary state or dried, or of carbonic acid gas, according to the prevailing temperature and other circumstances. Through these manipulations a perfectly dry powder is finally obtained, which, being hermetically sealed in glass or tin cases, will keep perfectly well for several months. When required to be used, the powder is mixed with water to the consistency of a thin paste, which acts in the same way as fresh yeast. (Jeversen and Beldt.)

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